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TRACK STANDARDS

Edited by

NORMAN F. REHM

(Editor, Railway Engineering and Maintenance of Way.)

FIRST EDITION

UNIVERSITY OF MICHIGAN

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1910

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PREFACE

The subject matter of this book is to be revised annually and published after the annual convention of the American Railway Engineering and Maintenance of Way Association. The information in this book was obtained for the most part from officers of the railway companies represented. All other matter contained therein has reference to the standards of the Maintenance of Way Association, and is published in order to afford a comparison with prevailing railway standards.

In this first edition there will undoubtedly be numerous errors both on account of the difficulty in checking the data presented, and also to unavoidable delays in printing this first edition.

We wish to thank the railway officials who have assisted us in compiling the standards which we hope will afford a means of comparison for all maintenance of way men. We ask the co-operation of all railway men interested in this work in revising the book for the second edition.

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TRACK STANDARDS

CHAPTER I.

American Roadway Practice

THE standard track sections, adopted by American railways, vary considerably in all dimensions, but this fact is due in the main to the conditions which exist on the various roads. Among the reasons for this variation may be noted the frequency and weight of traffic, the speed of trains and climatic conditions. It is acknowledged, however, that universal standards may be designed for several classes of track, which would require only slight changes, if any, to be applicable for all roads.

The width of roadbed for single track main line is between 18 and 20 feet, with few exceptions, and for double track between 30 and 33 feet. Such widths have proved very satisfactory and therefore have become very general. There are, however, localities, particularly the rocky, mountainous sections of the country, where it is not feasible to use greater than a 16 or 17-foot width. The width of roadbed on less important main lines and branch lines is somewhat smaller, varying between 16 and 18 feet. The standards of the American Railway Engineering and Maintenance of Way Association give three widths of roadbed, 20, 16 and 14 feet for the three classes of road-

bed, but the practice on most roads is not to decrease the width of roadbed in such proportions. The initial cost of roadway construction is greater, but the cost of maintenance lower, with the greater width of roadbed, that is, a width between 18 to 20 feet.

The depth of ballast which is customary on main lines is 12 inches. It is the practice, however, on several roads to limit the amount of ballast beneath the ties to 7 or 8 inches, on account of the constituency of the soil. It has been recommended that the minimum amount of ballast should be 12 inches with substantial subsoil and that 18 inches would give best service, but it is not likely that roadways will be built of such proportions unless the cost of ballast is materially decreased, and unless serious difficulties are encountered in maintaining roadway with the present 12 inches of ballast.

The slope of the roadbed depends upon the character of the subsoil and varies between a level surface and a slope of 12 to 1. An average slope would be about 24 to 1, or 5 inches on a 20-foot roadbed. On a substantial firm sub-soil a slope to the roadbed is not deemed necessary to provide drainage, but very often a rise of 1 or 2 inches is given on an 18 to 20-foot roadway.

The slope of the ballast depends upon the material. With crushed rock ballast or slag it is customary to give a slope of 1.5 to 1, but there are cases where the slope is less than 1.5 to 1, and then again where it is as high as 2 to 1. With other materials the slope of ballast increases to 3 to 1, which slope is recommended as good practice.

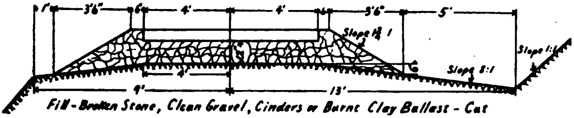
The practice of sodding the roadbed up to the foot of ballast is becoming more general. The sod protects the subgrade and maintains the section against washouts. If sod were not used it would frequently be necessary to provide a heavy material to prevent the wearing away of the subgrade.

The distance between centers of double track is usually 13 feet. There are a few roads on which this distance exceeds 13 feet and very few on which it is less.

Drainage of the roadbed may be provided for with ditches and drains. The dimensions of ditch depend upon such conditions as climate, rainfall and extent of drainage area that must be handled. Where the water to be disposed of is very heavy, ditches are supplemented by drains. In cold climates the heaving of track is avoided to some extent by careful drainage, and at the same time the use of shims may be abandoned.

Various opinions are advanced as to the best practice in the use of drains. Certain points in reference thereto are mentioned here. In the first place it is necessary to provide a good foundation for the tiling in order that it may not shift position, become clogged and therefore be of small value. The depth should be such that the subgrade will be thoroughly drained and therefore a depth of 2 or 3 feet below surface of subgrade should prove efficient. Drains are located beneath the center of ditch in a trench and covered completely with cinders. On double-track, cross-drains are used in cuts and these are placed on a slope at the surface of roadbed to carry the water to ditches or to drains parallel with the track.

Standard Roadway Sections



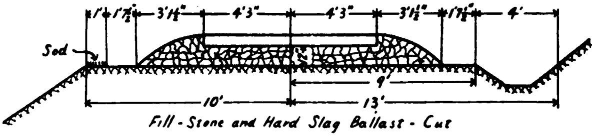
Atchison, Topeka & Santa Fe Track Section.

ATCHISON, TOPEKA & SANTE FE RAILWAY.—This road has four track sections both for broken stone, clean gravel, cinders or burnt clay ballast, and for cementing gravel ballast, besides section for earth or material that will not drain and desert section. The roadbed has the same width for all ballast sections, but the depth of ballast decreases from 12 inches to 6 inches and the distance from tie to foot of ballast decreases from 4 feet to 2 feet 10 inches with the kind of ballast indicated in drawing, and from 4 feet 4 inches to 2 feet with cementing gravel ballast. Where the fill is over 10 feet in height the width of roadbed is 20 feet instead of 18 feet.

The slope of roadbed is the same for all sections, but the slope of ballast is not the same for cementing gravel as for the kind of ballast shown in section. The slope for cementing gravel has a 2 to 1 ratio from foot of ballast to a point 1 foot 4 inches from end of tie where the slope changes, the ballast becoming level with upper face of tie at a point 1 foot 9 inches from center of roadbed and being 3 inches from upper face of tie at end of tie.

With the 6x8-inch by 8-foot ties which are used 3,400 cubic yards of ballast per mile are required in the section, illustrated herewith. The variation in cubic yards of ballast per mile for the several track

sections with broken stone, clean gravel cinders or burnt clay ballast is between 3,400 and 1,940 cubic yards per mile, and with the cementing gravel ballast between 3,470 and 1,880 cubic yards per mile.



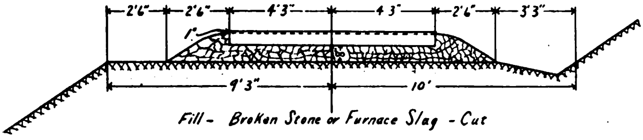
Baltimore & Ohio Track Section.

Baltimore & Ohio Railroad.—There are three classes of track sections, A, B and C, both for stone or hard slag ballast and for gravel, cinder or granulated slag ballast. The width of roadbed on fills varies from 20 to 16 feet for the three classes, with 6 feet additional width in cuts, while the depth of ballast decreases from 12 to 6 inches. The distance from foot of ballast to end of tie varies between 3 feet 1½ inches (class A) and 2 feet 9 inches (class C) with stone and hard slag ballast and between 3 feet 9 inches and 2 feet 1¼ inches with gravel, cinder or granulated slag ballast.

With the latter kind of ballast the slope is made on practically a straight line from inside of rail to foot of ballast in cases where the ballast is very dirty or cements badly so that it does not drain properly.

Slopes of cuts are made generally as follows: Solid rock, ¼ to 1; loose rock, ½ to 1, and earth, 1 to 1 and 1½ to 1. All earth slopes, cuts and fills are made 1½ to 1, except where it is advisable to alter to suit the character of material.

On curves the depth of ballast is maintained at 12 inches under lower rail for class A. On double track the distance between centers of track is 13 feet and width of roadbed is 33 feet on fills.



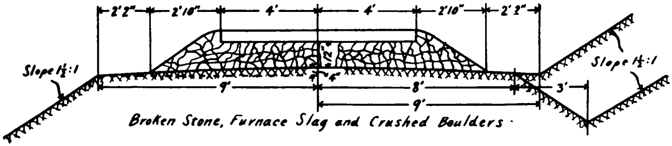
Central Railroad Of New Jersey Track Section.

Central Railroad of New Jersey.—Besides the section, shown herewith, for broken stone or furnace slag, there is one for engine ashes. The width of roadbed and depth of ballast is the same for both kinds of ballast. With the ballast of engine ashes the distance from end of tie to foot of ballast is 4 feet, the ballast being 1 inch from upper face of tie throughout length of tie and in cuts the roadbed slope is 10 to 1 from point beneath tie to bottom of ditch, 1 foot beyond foot of ballast.

The slope of embankments is 1½ to 1 and of cuts is as follows: Solid rock, ¼ to 1; broken stratified rock, ½ to 1; stiff earth, 1 to 1, and loose earth, 1½ to 1. In wet cuts the width of roadbed is made 26 feet and 2 feet of berme is maintained on the subgrade, the depth of ditch being 9 inches or more.

The minimum depth of ballast allowable under the ties is 4 inches, the standard being 8 inches. On curves the subgrade must slope so as to maintain these depths beneath lower rail. The width of roadbed for double track is 31 feet 6 inches on fills and

33 feet in cuts, these widths being the same for tracks on 12 or 13-foot centers. When such changes or repairs are in progress that admit of work being done at least cost, tracks are spread to 13 feet centers. In new construction engine ashes are used for ballast on all fills until they are thoroughly settled.

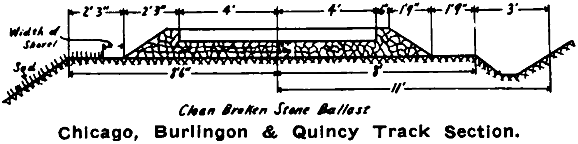


Chicago & Alton Track Section.

Chicago & Alton Railway.—The standard main track section with ballast of broken stone, furnace slag or crushed boulders is shown herewith. With gravel ballast the main track section is similar to the above with the exception of ballast slope. Gravel ballast is sloped from center of roadbed on a curve and is level with bottom of tie at the end of tie.

For double main track, the width of roadbed is 31 feet, the distance between centers of track being 13 feet. Between tracks large boulders are used instead of broken stone, etc., where the ballast is level with upper face of tie.

For side track, engine cinder ballast is used and its section is similar to that for broken stone ballast.



Chicago, Burlingon & Quincy Track Section.

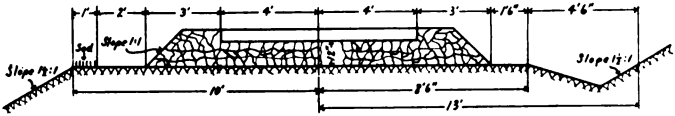
CHICAGO, BURLINGTON & QUINCY RAILWAY.—For the standard track section with stone ballast, 2,146 cubic yards of ballast are required on a basis of 3,100 ties, 6x8 inches by 8 feet, per mile.

With burned clay or clean fair-sized gravel, the depth of ballast and width of roadbed is the same as for stone ballast. The ballast has a slope of 1½ to 1 from a point 10 inches from tie to foot of ballast, which is 2 feet 7 inches from end of tie. 2,273 cubic yards per mile. Sod line is 7 feet 10 inches from center of track.

The slope of embankment in good earth is 1½ to 1 and in clear sand or sliding earth the slope is less, some sands requiring a 2 to 1 slope. In cuts, the earth slope is 1½ to 1 and the rock slope is ¼ to 1.

The width of roadbed on fills is maintained at 17 feet, new banks being constructed wider where it is necessary to insure 17 feet after settlement. Ditches are made approximately as indicated, the outline being as section scraper leaves it. Six-inch tile is located about 4 feet below subgrade.

For sidings and unimportant lines where no ballast and track is surfaced with material from side, the roadbed is 14 feet wide on fills and 20 feet in cuts. When earth is used, it is just level with bottom of tie at end of tie so as to drain well. The tie is lifted just



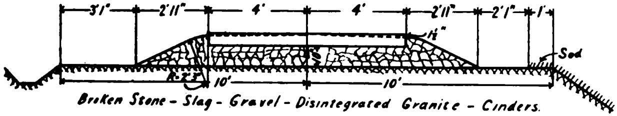
Rock Ballast

Chicago & Northwestern Track Section.

enough to bring track to surface and tamp. The clearance between rail and earth is 2 inches.

CHICAGO & NORTHWESTERN RAILWAY.—The standard track section for rock ballast is shown herewith. With gravel ballast the track section varies from the above only in the ballast section, which has a slope from center of roadbed that gives 1 inch clearance under rail and 4 inches below upper face of tie at end of tie and which is 1½ to 1 from a point 1 foot 6 inches from tie to foot of ballast. At the center of roadbed, the gravel ballast is therefore about 3 inches above tie.

The double track sections are similar to single track, the distance between center of track being 13 feet. The width of roadbed is therefore 33 feet on fills and 39 feet in cuts.



Chicago, Rock Island & Pacific Track Section.

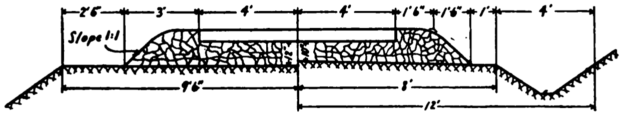
CHICAGO, ROCK ISLAND & PACIFIC RAILWAY.—There are three classes of track sections, designated by A, B, and C, with widths of roadbed 20, 18 and 16 feet respectively. Under classes A and B, sections are given for broken stone, slag, gravel, disintegrated granite and cinders, for chats and sand and for earth. Under class C, sections for chats and sand are not included. For each kind of ballast the sections under each class are given for 6, 7, 8, 9 and 10 inches of ballast under tie.

The section, shown herewith, requires 2,495 cubic yards of ballast per mile, the estimate of quantity being

based on 3,200 ties, 6x8 inches by 8 feet, per mile. The cross-section of ballast does not vary with width of roadbed, but only with depth of ballast. The cubic yards of ballast per mile, which are required for the sections of broken stone, slag, etc., vary between 2,495 and 1,644 cubic yards with ballast depths of 10 to 6 inches respectively. For chats and sand the variation is between 2,938 and 1,988 cubic yards with ballast depths of 10 to 6 inches respectively.

For double track, cubic yards of ballast per mile for broken stone, slag, etc., vary between 5,347 and 3,645 cubic yards under same conditions and for chats and sand between 5,852 and 4,055 cubic yards.

The section and area of ditch are governed by local conditions. The distance between centers of track is 13 feet.

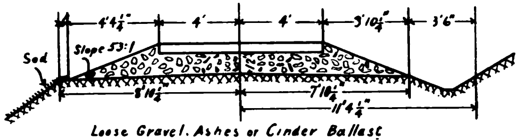


Chicago, St. Paul, Minneapolis & Omaha Track Section.

CHICAGO, ST. PAUL, MINNEAPOLIS & OMAHA RAILWAY.—It will be noted in the drawing that the depth of ballast under center of ties is 2 inches less in cuts and that the subgrade has a slope of 2 inches in 7 feet.

With gravel, cinders or very coarse sand ballast, the width of roadbed and depth of ballast is the same as for stone ballast. The distance from end of tie to foot of ballast on fills is 4 feet and in cuts 3 feet. The ballast slopes so as to give about an inch clearance under rail and from a point 2 feet from foot has a slope of 1½ to 1.

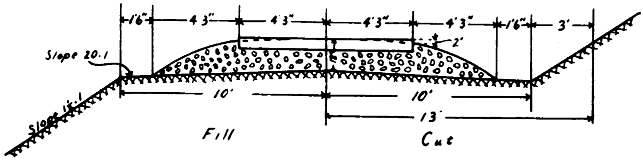
With ties laid on earth, the width of roadbed on fills is 14 feet and in cuts is 24 feet.



Cincinnati, Hamilton & Dayton Track Section.

CINCINNATI, HAMILTON & DAYTON RAILWAY.—The standard track section for cementing gravel ballast is similar to the section for loose gravel, ashes or cinder ballast with the exception of ballast slope which in the case of cementing gravel is on a straight line from a point at end of tie and 4 inches below upper face of tie to foot of ballast 3 feet 10¼ inches from end of tie. The ties are 6x8 inches by 8 feet. The slope of subgrade is 2 inches in one-half the width of roadbed. It will be noted in the above drawing that 6 inches of sod are used on subgrade for embankments, but that there is no berme on subgrade for cuts. Below center of ditches 6-inch tile is placed 6 inches below surface of ditch or 14 inches below subgrade.

This section was adopted as a standard for the reason that it was adapted to the roadbed generally existing on its line.

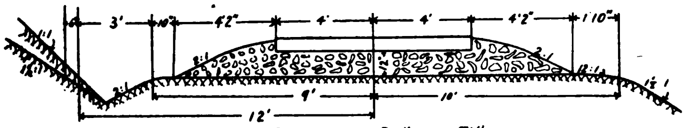


Delaware & Hudson Track Section.

DELAWARE & HUDSON COMPANY.—It will be noted

that the depth of ballast is 12 inches below center of tie and the slope of subgrade is 6 inches in one-half the width of roadbed. The slope of cut or embankments is 1½ to 1.

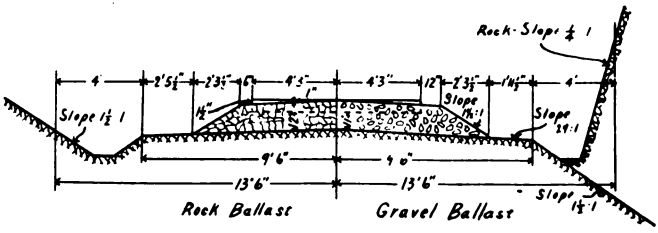
On double-track roadbed the ballast at center of roadbed is 18 inches in depth and the slope of subgrade is 6 inches in 16 feet (one-half width of double-track roadbed). The depth of ballast under center of tie is therefore about 14 inches for double-track. The distance between centers of track is 12 feet.



Denver & Rio Grande Track Section.

Denver & Rio Grande Railroad.—The width of roadbed is the same for the four standard roadbed sections with gravel ballast. The depth of ballast decreases from 12 to 6 inches and the distance from end of tie to foot of ballast decreases from 4 feet 2 inches to 3 feet 2 inches. The ties are 7 inches in depth.

The cubic yards of ballast per mile for 6, 8, 10 and 12 inches of ballast under the tie is 2,070, 2,550, 3,050



Erie Track Section.

and 3,570 for single track and 4,340, 5,305, 6,295, and 7,305 for double track.

Erie Railroad.—With rock and gravel ballast, for which track sections are shown herewith, it will be noted that the depth of ballast under center of tie is 11 inches and the subgrade has a slope of 4 inches in one-half width of roadbed. The depth of tie is 7 inches. The ballast area with rock ballast is 17.36 square feet and with gravel 19.64 square feet; the cubic yards of ballast per mile with rock is 3,152 and with gravel 3,596.

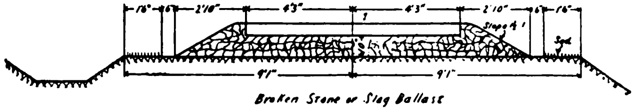
The slope of embankments is made 1½ to 1, and of cuts is made for rock ¼ to 1 least and 1½ to 1 for earth. Under rails there is a clearance of 1 inch between ballast and rail to allow for unbroken electric track circuit. Drain tile is used, where it is deemed necessary, and is laid on 1x6-inch plank 3 feet below bottom of ditch at center, being given a fall of at least 3 inches in 100 feet.

On single track curves the depth of ballast under lower rail is 12 inches, the ballast area for rock varies between 17.36 and 22.68 square feet and for gravel between 19.64 and 24.96 square feet, and the cubic yards of ballast per mile for rock varies between 3,152 and 4,192 and for gravel between 3,596 and 4,636. The greatest superelevation figured on is 8 inches, and a special order is required for more than 6 inches superelevation.

For double track the subgrade has a slope of 6 inches in 20 feet (one-half width of roadbed), and the depth of ballast under inner rail is 12 inches. The distance between center of track is 13 feet. On tangent double track, the rock ballast area in square feet and cubic yards of rock ballast per mile are 37.5 and 7,092 respectively,

and the gravel ballast area in square feet and cubic yards of gravel ballast per mile are 39.78 and 7,536 respectively.

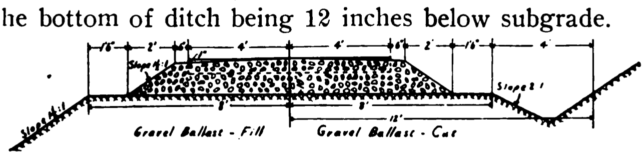
On double track curve the rock ballast area in square feet and cubic yards of rock ballast per mile vary from 37.5 to 45.97 and from 7,092 to 8,747 respectively, and the gravel ballast area in square feet and cubic yards of gravel ballast per mile vary from 39.78 to 48.25 and from 7,536 to 9,191 respectively. The inside rails on curves are on same level plane.



Grand Rapids & Indiana Track Section.

GRAND RAPIDS & INDIANA RAILWAY.—The width of standard roadbed for gravel or cinder ballast is the same as for slag or broken stone ballast, shown herewith. With the gravel or engine cinder ballast the depth of ballast under tie is 8 inches and the distance from end of tie to foot of ballast is 3 feet 4 inches, allowing 18 inches sod. The slope of the latter ballast is on a curve of 25.18 foot radius from center of tie to foot of ballast. The depth of tie is 6 inches.

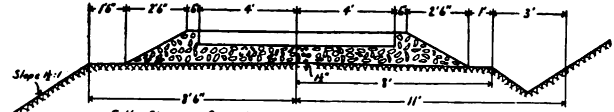
The slope of embankments and dry cuts is made 1½ to 1. For wet cuts, a ditch of variable width is used. the bottom of ditch being 12 inches below subgrade.



Great Northern Track Section.

Great Northern Railway.—The standard roadbed section, for single track with gravel ballast is shown on opposite page. The depth of tie is 7 inches. Where a surplus of ballast is distributed the slope of 1½ to 1 is maintained approximately and the shoulder at top is increased from 6 inches, thus decreasing width of berme on sub-grade.

The distance between centers of track is 15 feet. The depth of gravel between track is 10 inches, but where a passing track is lower than the main track, the gravel between tracks is kept level with bottom of tie of passing track.



Fill- Sherman Gravel, Burnt Clay or Cinder Ballast - Cut

Harriman Lines Track Section.

Harriman Lines.—The standard track sections are common to all Harriman lines, which include among others the Oregon Railroad & Navigation Company lines, the Oregon Short Line, the Southern Pacific System and the Union Pacific Railway.

The standard track section with Sherman gravel, burnt clay or cinder ballast is shown above. The ties are 7x9 inches by 8 feet. The subgrade has a slope of 1½ inches in one-half width of roadbed. The slope for embankments or cut is 1½ to 1 with the exception of rock cuts, where slope is ¼ to 1 and the ditch is 18 inches wide at subgrade, 12 inches deep and 12 inches wide at bottom. The width of shoulder and roadbed may be increased up to 12 inches to suit variations in quality of

gravel. With this ballast section, 2,573 cubic yards of ballast are required per mile.

The track section with broken stone or slag ballast differs in that the distance from end of tie to foot of ballast is 2 feet 6 inches, giving a width of roadbed on fills of 16 feet and in cuts of 21 feet. The ballast per mile required is 2,449 cubic yards.

Where ties are placed on earth, the width of roadbed on fills is 17 feet 6 inches and in cuts is 21 feet. Where the ties are placed on sand or other permeable material through which water drains quickly, the width of roadbed on fills is 17 feet 6 inches and in cuts is 19 feet 10½ inches. The latter section is used for particular localities in arid regions only when properly authorized.

The double track sections have detail dimensions common with single track. The distance between track centers is 13 feet and the subgrade slopes from center of roadbed, having the same fall as single track. On account of subgrade slope the depth of ballast under tie on the inside is slightly less than 8 inches. For the section with gravel, burnt clay or cinder ballast, 5,130 cubic yards of ballast are required per mile and for the section with Sherman gravel, broken stone or slag ballast 5,000 cubic yards are required.

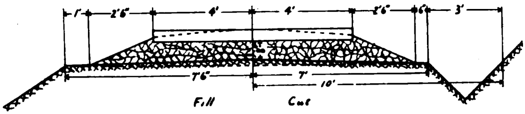
ILLINOIS CENTRAL RAILROAD.—The use of one of the several classes of roadbed, A, B, or C, depends upon the importance of the section of line with regard to speed, weight and frequency of traffic. The sections of class A are used on the important main lines, the through lines for passenger and heavy freight service. Those of class B, are used on main lines also, but lines which are of

lesser importance. Class C sections are used only on branch lines of the road.

The variation in the different classes is in the width of roadbed and depth of ballast. Class A section has a 20-foot width of roadbed, class B has an 18-foot and class C has a 16-foot. There is a depth of ballast of 12 inches for class A, 10 inches for class B, and 8 inches for class C.

Different sizes of ties are used on several sections of the road. The standard tie for new lines is the 6x8-inch by 8-foot. The 7x9-inch by 8½-foot tie is used on a section of line upon which the tie was already laid at the time of purchase by the I. C. R. R. The 7x9-inch by 9-foot tie is a cypress cross-tie which is used in the states of Louisiana and Mississippi, the southern extremity of the road.

The ballast to be used, depends upon the location of the section of the road with respect to the source of supply. Rock ballast, cementing gravel ballast and loose gravel and cinder ballast are the kinds which are used, depending upon the importance of the line. The cementing gravel ballast is a mixture of gravel and clay, which gives a compact roadbed.

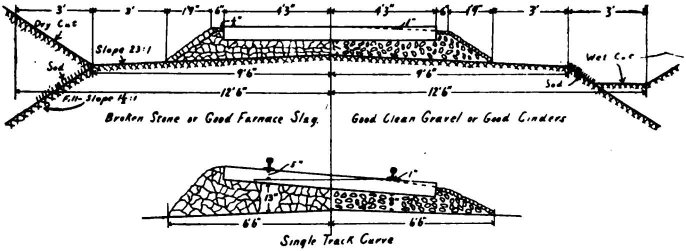


Kansas City, Mexico & Orient Track Section.

KANSAS CITY, MEXICO & ORIENT RAILWAY OF TEXAS. —The standard track sections for earth embankment and

cut are shown in the drawing on page 23. At the foot of embankment the berme is 10 feet wide.

In rock cuts the width of roadbed at subgrade is 20 feet, crushed rock being used to a depth of 12 inches below subgrade. The width of ditch at subgrade is 3 feet and at bottom is 1 foot 1½ inches, the bottom being 1 foot 6 inches below subgrade. The side slope of cut is 1¼ to 1.

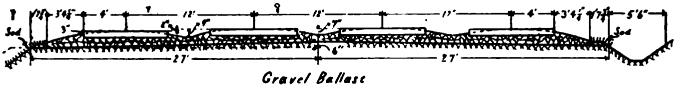


Lehigh Valley Track Section.

Lehigh Valley Railroad.—The track sections for the several kinds of ballast are the same with the exception of ballast slopes. For broken stone or good furnace slag ballast and for good, clean gravel or good cinder ballast the slopes are shown in the accompanying drawing. With poor gravel or clay, the ballast slopes from center of roadbed to a point a few inches beyond rail so as to give 1 inch clearance between rail and ballast and then on a straight line to foot of ballast 3 feet beyond end of tie. The subgrade has a slope of 5 inches in 9 feet 6 inches in all cases.

On single track curves the depth of ballast is shown in the above drawing for a superelevation of 5 inches, the distance from center of roadbed to foot of ballast being 6 feet 6 inches as on tangent single track.

The distance between centers of track is 13 feet. The slope of subgrade from center of double track roadbed is 5 inches in 16 feet.



New York Central & Hudson River Track Section.

New York Central & Hudson River Railroad.— In the accompanying drawing, the standard track section for gravel ballast and four tracks is shown. The depth of ballast under center of tie from upper face of tie is about 15 inches for the inner tracks and 16 inches for the outer tracks.

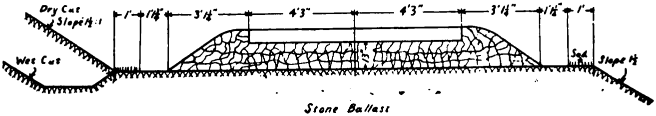
In wet cuts, farm tile, 6 or 8 inches, is used and protected by sod covering. In soft material the tile is laid in troughs, 5 feet below subgrade. The ditch is filled with clean gravel in the immediate vicinity of the tile and with porous material above the gravel. The ditch opposite drain boxes is also filled with cobbles.

The box drains are made 6x6 inches of 2-inch planks and are placed 400 to 500 feet apart for draining depressions between tracks ballasted with gravel. The drains are placed deep enough to permit tamping and have an inclination of 1-inch per foot each way from center line of roadbed. The box drains are placed between ties under three of the tracks, one of the inner and two of the outer. Cobbles are used at drain openings and cover an area of 2 feet 6 inches by 3 feet. These box drains are of creosoted timber.

When the cuts are unusually wet, drains are also placed

between track. When drains are unusually long, the diameter is increased near outlet.

The distance between centers of track is made 13 feet wherever possible, but in no case less than 12 feet. The distance from center of main track to center of adjacent siding is 13 feet.



Penn. Lines, W. of P. Track Section.

PENNSYLVANIA LINES WEST OF PITTSBURG.—There are two classes of track which differ mainly in depth of ballast and width of roadbed. The section for class A track with rock ballast is shown above, but a proposed revision to change slope of ballast to 1½ to 1 is not indicated. Ties are 7x8 inches by 8 feet 6 inches.

On class A track with gravel or engine cinder ballast, the depth of ballast and width of roadbed are the same as with rock ballast, but the slope of ballast is from upper face of tie, about 14 inches from center to foot of ballast, 4 feet 3 inches from end of tie, on a curve of 22.59 foot radius. The berme of width 12 inches is covered with sod.

On class B track with gravel or engine cinder ballast the depth of ballast is 8 inches, the width of roadbed is 17 feet and the distance from end of tie to foot of ballast is 3 feet 3 inches, but the slope is same as for gravel ballast on class A track.

The size of ditch is governed by local conditions de-

pending on quantity of water and drainage. The slope of embankment or cut is made 1½ to 1.

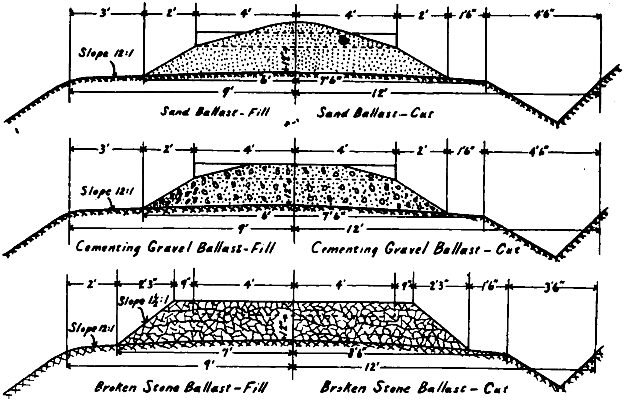
The distance between centers of track is 13 feet and the ballast between ties is level with upper face of tie. The inside rails on curves are on same elevation.

Pere Marquette Track Section.

Pere Marquette Railroad.—The standard track sections are divided into three classes, for main line, less important main line and branches. The width of roadbed decreases for the several classes from 18 to 14 feet on fills and the depth of ballast from 12 to 6 inches. If fills are over 8 feet, the width of roadbed is increased 2 feet for each class and it may also be increased on account of material or to provide necessary drainage. The width of roadbed in cuts is 6 feet greater than on fills. The depths of ballast given above are for sand subsoil and are decreased 1½ inches at center of roadbed, if subsoil is clay or loam. The distance from end of tie to foot of ballast decreases from 4 feet to 2 feet 4 inches.

On double track the roadbed is 32 feet wide on fills, with a distance of 14 feet between centers of track. The subgrade is level with sand subsoil and has a slope of 1½ inches in 16 feet with clay or loam subsoil. The width of roadbed is 2 feet greater on fills over 8 feet.

PHILADELPHIA & READING RAILWAY.—See description of roadway for Central Railroad of New Jersey, which is the same.

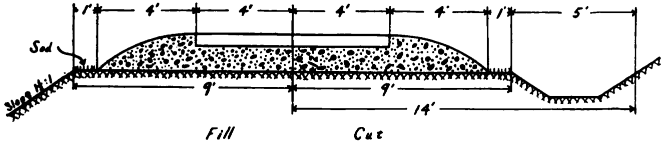


St. Louis Southwestern Track Section.

ST. LOUIS SOUTHWESTERN RAILWAY.—The width of roadbed and depth of ballast are the same for all track sections, three of which are shown in the above drawing. The track section with cinder or fine gravel ballast is same as that for broken stone ballast, with several exceptions outlined as follows: The width of ballast shoulder is 6 inches instead of 9 inches; the width of berme on fills is 2 feet 3 inches instead of 2 feet, and the width of ditch is 3 feet 9 inches instead of 3 feet 6 inches. In the track section for ties laid on earth, the earth rises above tie between rails. It will be noted that the slope of subgrade is 1 inch in 12 inches for all sections.

WABASH RAILROAD.—There are two classes of track of which class A is shown herewith. On class B track the

width of roadbed on fills is 16 feet and in cuts is 24 feet, with ditch 4 feet in width; the depth of ballast is 8 inches under tie and distance from end of tie to foot of ballast is 3 feet.



Wabash Track Section.

The distance between centers of track is 13 feet and the ballast between ties is maintained at level of tie.

The quantities of ballast per lineal foot of track are as follows: Class A, single track, 0.70 cubic yards; class B, single track, 0.48 cubic yards; class A, double track, 1.37 cubic inches, and class B, double track, 0.98 cubic inches.

Standard Roadway Dimensions

The accompanying tables, giving certain dimensions of standard track sections, are for three classes of track, A, B and C, which are subdivided as follows:

Class A:
- (1) Important Main Line.
- (2) Crushed Rock and Slag.
- (3) Gravel, Cinders, Chats, etc.

Class B:
- (1) Less Important Main Line.
- (2) Crushed Rock and Slag.
- (3) Gravel, Cinders, Chats, etc.
- (4) Cementing Gravel and Chert.

Class C:
- (1) Branch Lines.
- (2) Gravel, Cinders, Chats, etc.
- (3) Cementing Gravel and Chert.
- (4) Poor Gravel, Sand, Clay, etc.

It will be understood that all the track sections are not included in the following tables. Only the sections which indicate best the practice of the railroad were given. The division and subdivision was made to agree with the above form where it was possible, but in some cases it was effected at the discretion of the writer.

TABLE I—CLASS A.

Railroad—	Division of class A	Width of Road-bed (feet)	Distance from tie to foot of ballast	Depth of Ballast (inches)	Length and depth of tie (feet-inches)	Distance between track centers (feet) Depth of Ballast (inches)
A. T. & S. F.	2-3	18, 20	4	12	8-6	..
B. & O.	2	20	3 3/24	12	8½-7	13
C. R. R. of N. J.	2	18 ½	2 1/2	8	8½-7	13
C. & A.	2	18	2 5/6	12	8-6	13
C. & N-W.	2	20	3	12	8-6	13
C. B. & Q.	2	17	2 1/4	8	8-6	..
C. R. I. & P.	2	20	2 11/12	10	8-6	13
C., St. P., M. & O.	2	19	3	12	8-6	..
C., H. & D.	3	17 17/24	4 17/48	12	8-6	..
D. & H.	.	20	4 1/4	11	8½-7	13
D. & R. G.	2	20	3 1/2	8	8-7	15
Erie	2	19	2 19/24	11	8½-7	13
G. R. & I.	2	18 1/6	2 5/6	10	8½-6	..
G. N.	3	16	2 1/2	10	8-7	15
Harriman Lines	3	17	3	8	8-7	13
Illinois Central	1-2	20	4 1/4	12	8-6	14
K. C., M. & O.	.	15	2 1/2	8	8-6	15
Lehigh Valley	2	19	2 1/4	7	8½-7	13
N. Y. C. & H. R.	3	18	3 17/48	12	8-6, 7	13
Pere Marquette	1	18	4	12	8-6	14
Phila. & Reading	2	18 1/2	2 1/2	8	8½-7	13
P. L. W. of P.	2	19	3 5/48	13	8½-7	13
St. L. S-W.	2	18	3	12	8-6	..
Wabash	.	18	4	12	8-6	13

TABLE II—CLASS B.

Railroad—	Division of class B	Width of Roadbed (feet)	Distance from tie to foot of ballast (feet)	Depth of Ballast (inches)	Length and depth of tie (feet-inches)	Distance between track center (feet)
A. T. & S. F.	2-3	18, 20	3 7/12	10	8-6	..
B. & O.	2	18	2 11/12	9	8½-7	..
C. R. R. of N. J.	3	18 1/2	4	8	8½-7	13
C., R. I. & P.	2	18	2 7/12	8	8-6	13
C., H. & D.	4	17 17/24	4 17/48	12	8-6	..
D. & R. G.	3	20	4 1/6	12	8-7	15
Erie	3	19	3 7/24	11	8½-7	13
G. R. & I.	3	18 1/6	3 1/3	8	8½-6	..
Harriman Lines	2	16	2 1/2	8	8-7	13
Illinois Central	1-3	18	3 1/2	10	8-6	..
Lehigh Valley	2	19	2 1/4	7	8½-7	13
Pere Marquette	1	16	3 1/6	9	8-6	..
Phila. & Reading	3	18 1/2	4	8	8½-7	13
P. L. W. of P.	3	17	3 1/4	8	8½-7	13
St. L. S-W.	4	18	2	12	8-6	..
Wabash	..	16	3	8	8-6	13

TABLE III—CLASS C.

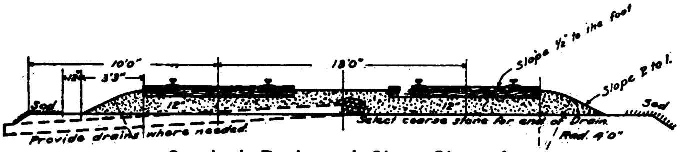
A., T. & S. F.	3	18, 20	3 5/6	8	8-6	..
B. & O.	2	16	2 5/48	6	8½-7	..
C., R. I. & P.	2	16	2 1/4	6	8-6	13
D. & R. G.	3	20	3 5/6	10	8-7	15
Illinois Central	1-2	16	2 3/4	8	8-6	..
Pere Marquette	1	14	2 1/3	6	8-6	..
St. L. S-W.	4	18	2	12	8-6	.

AMERICAN RAILWAY ENGINEERING AND MAINTENANCE OF WAY ASSOCIATION BALLAST SECTIONS.

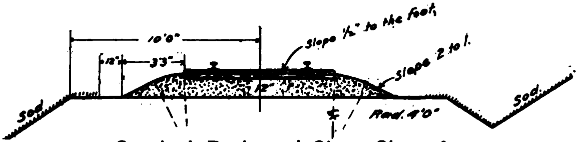
The following ballast sections illustrate good practice as suggested by the American Railway Engineering and Maintenance of Way Association:

"The sections for Class A track are intended to show minimum depth under ties and are recommended for use only on the firmest, most substantial and well-drained sub-grades.

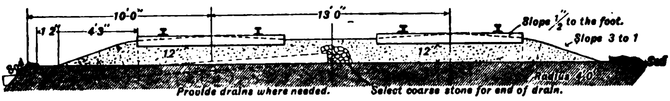
"The sodding of the roadbed shoulder next to ditch and of the slopes of the ditch are recommended."



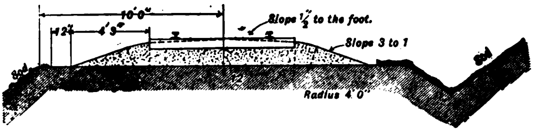
Crushed Rock and Slag—Class A.



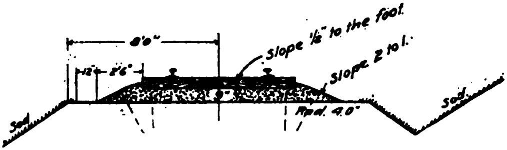
Crushed Rock and Slag—Class A.



Gravel, Cinders, Chats, etc.—Class A.

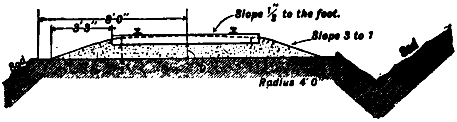


Gravel, Cinders, Chats, etc.—Class A.

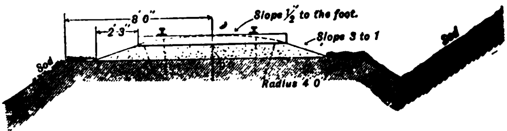


Crushed Rock and Slag, Class B.

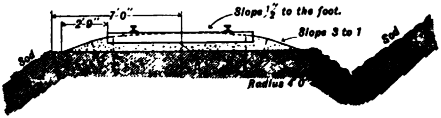
Note. The slag which should be dressed to section shown for crushed rock and slag, is broken slag, similar in its character to crushed rock, granulated slag should be dressed to section shown for gravel, cinders, chats, etc.



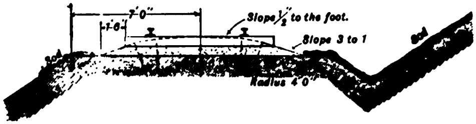
Gravel, Cinders, Chats, etc.—Class B.



Cementing Gravel and Cheat—Class B.



Gravel, Cinders, Chats, etc.—Class C.



Cementing Gravel and Cheat—Class C.

CHAPTER II.

Ties

IN this edition we do not attempt to illustrate ties, such as metal and concrete, for the reason that they are still in the experimental stage in so far as the adoption of standards. The information on standard specifications is given by the American Railway Engineering and Maintenance of Way Association as follows:

RECOMMENDED STANDARD SPECIFICATIONS.*

1. The following woods may be used for tie timber without any preservative treatment:

White Oak family.
Long-leaf strict heart yellow pine.
Cypress, excepting the white cypress.
Redwood.
White Cedar.
Chestnut.
Catalpa,
Locust, except the honey locust.
Walnut.
Black Cherry.

*From the proceedings of the American Railway Engineering and Maintenance Association.

2. The following woods shall preferably not be used for tie timber without a preservative treatment approved by the purchaser:

Red Oak family.

Beech.

Elm.

Maple.

Gum.

Loblolly, short-leaf, lodgepole, Western yellow pine, Norway, North Carolina pine and other sap pines.

Red fir.

Spruce.

Hemlock.

Tamarack.

3. All ties shall be well and smoothly hewed or sawed out of straight, growing timber of specified dimensions and out of wind, sawed ends, with straight and parallel faces, the minimum width of either face to be not less than that given in the table of dimensions. All ties shall have bark entirely removed before being delivered on the company's ground. Ties shall be free from splits, shakes, loose or decayed knots, or any other imperfections which may impair their strength or durability.

4. Except in pole ties with rounded sides, or in half-round ties, none shall be less than eight (8) in. width of face, and in no tie shall the thickness be less than six (6) in. A variation in size will be permitted of one-half (½) in. over in thickness, two (2) in. over in width and one (1) in. over in length.

5. In pole ties with rounded sides and half-round ties, the width of face may be less than that given in the table of dimensions, but the least area of cross-section shall be not less than the area corresponding to the tabular dimensions, and in no case shall the width of face be less than six (6) in.

TABLE OF DIMENSIONS.

Class.	Thickness by Width of Face. Inches.	Feet.	Length. Feet.	Feet.
A	7 x 10	8	8½	9
B	7 x 9	8	8½	9
C	7 x 8	8	8½	9
D	6 x 9	8	8½	9
E	6 x 8	8	8½	9

CHAPTER III.

Rail

THE question of rail standards is now under consideration by a committee of the American Railway Engineering and Maintenance of Way Association, which reported in March, 1910, on rail sections as follows:

"Owing to the conditions existing in 1908 very little rail was laid, and practically none of the A. R. A. sections in such manner as to give the needed information. This year several roads have laid A. R. A. sections of rail. These rails have been in the track so short a time that we are not justified in drawing any conclusions as to which of the A. R. A. types is the better, or if either is better than the A. S. C. E. sections.

"The statistics for rail failures given in Bulletin No. 116 show that the difference in section can be entirely annihilated by difference in chemical composition and by the treatment in furnace and mill.

"The results so far obtained from the heavy base A. R. A. sections are disappointing, as we have received from the mills some rail of the new section which was as bad as we received with the old A. S. C. E. section.

"The tests to be inaugurated by the committee, combined with the results of the tests at Watertown and the performance of the rail in the track, will give us valuable data to aid us in coming to a final conclusion.

"The small demand, as indicated by mill sales data, and the slight possible variation in section of rail below 75 lbs. weight per yard makes inadvisable the consideration of new sections for this light-weight rail.

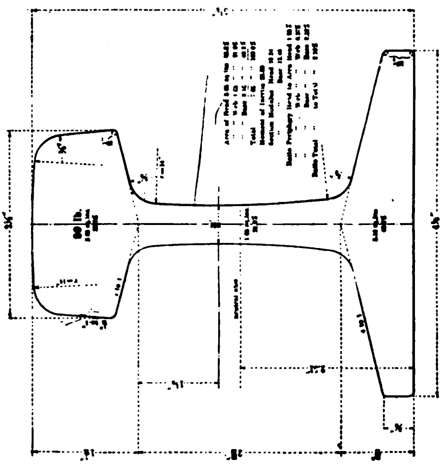
"No recommendation as to sections of 75 lbs. and over is made at this time because of the lack of undisputed data upon which to base such design, the service value of the rail unquestionably being dependent upon chemical composition, furnace practice and mill practice, as well as upon the detail differences of dimensions, and the exact effect of each of these various factors is largely in doubt."

A. R. A. RAIL SECTIONS.

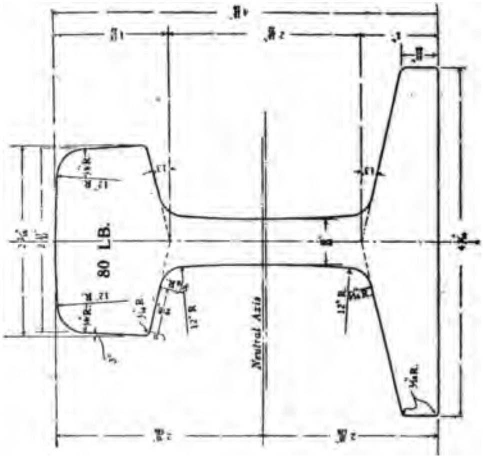
The following information was published in the January, 1908, issue of Railway Engineering and Maintenance of Way:

The rail sections, here illustrated, were recommended by the committee of the American Railway Association on "Standard Rail and Wheel Sections." The illustrations cover the two types of 80, 90 and 100-pound rails.

The principles involved in the design were agreed upon by the sub-committee. These principles are outlined as follows: First, the distribution of metal between head and base should be such as to insure the best control of temperature in the manufacture of the rail; second, the percentage of metal in the base should preferably be equal to or slightly exceed that in the head and the thickness at



Series A—Proposed 80-lb. Rail Section.



Series B—Proposed 80-lb. Rail Section.

extremities of flanges should be such as to permit the entire section to be rolled at low temperature, reducing internal stresses and extent of cold straightening to a minimum and also making the texture of the section more homogeneous; third, the proportioning of the sections should be such that they possess an amount of stiffness and strength that will secure the best conditions of manufacture and service, and fourth, certain limitations as to dimensions of details are advisable.

The limitations of the dimensions of details are as follows:

1. The width of base to be ½ inch less than the height.

2. The fishing angles to be not less than 13 degrees and not greater than 15 degrees.

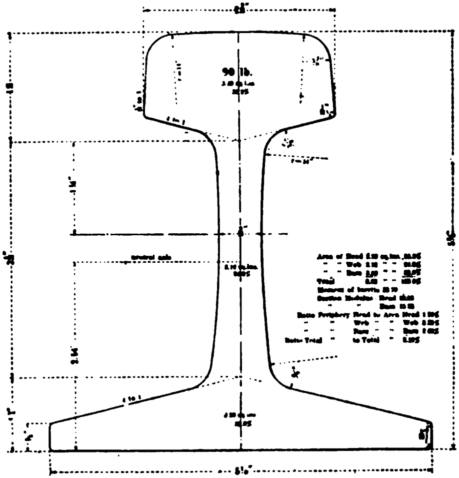
3. The thickness of the base to be greater than with existing sections of corresponding weight.

4. The thickness of the web to be no less than in existing A. S. C. E. sections of corresponding weight.

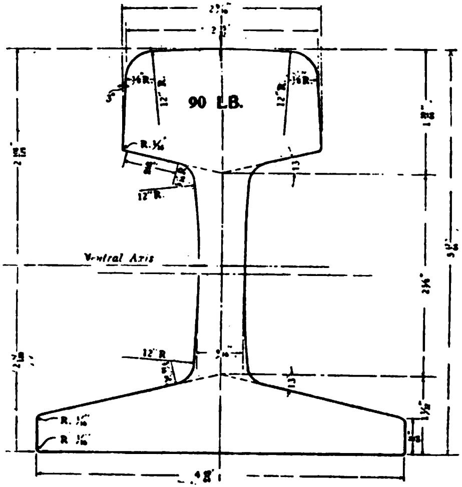
5. A fixed percentage of distribution of metal in head, web and base for the entire series of sections need not be adhered to, but each section in a series can be considered by itself.

6. The radii of the under corner of the head and top and bottom corners of the base to be as small as practicable with the colder conditions of rolling.

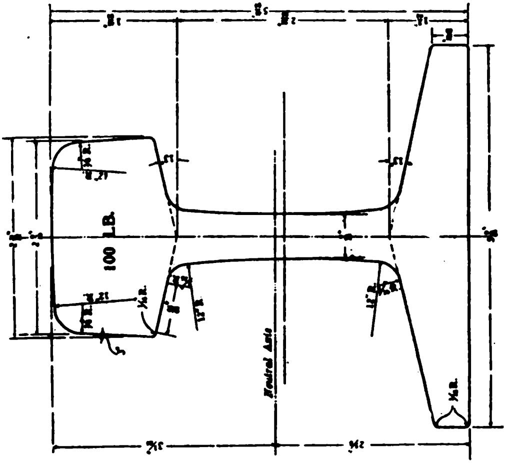
7. The radii of the fillets connecting the web with head and base to be as great as possible for reinforcement purposes, consistent with securing the necessary area for bearing surface under the head for the top of splice bar.



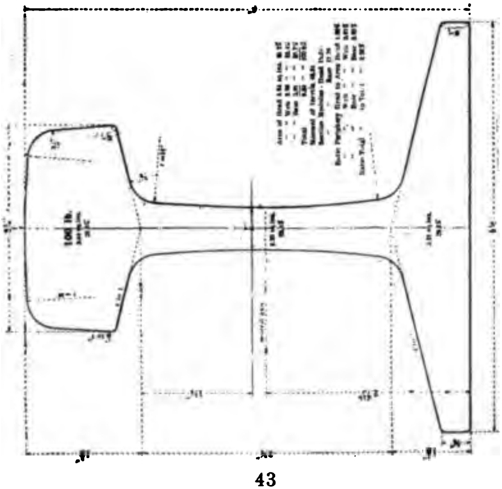
Series A—Proposed 90-lb. Rail Section.



Series B—Proposed 90-lb. Rail Section.



Series B—Proposed 100-lb. Rail Section.



Series A—Proposed 100-lb. Rail Section.

8. The sides of the head should be vertical or nearly so.

9. The radii of the top corners of the head should not be less than ⅜ inch.

The data for Series A rail sections is given with the illustrations and that for Series B rail sections is as follows:

Calculated weight, pounds	80.7	90.5	100.5
Area of head, square inches	3.07	3.56	3.95
Per cent of total	38.8	40.1	40.2
Area of web, square inches	1.54	1.70	1.89
Per cent of total	19.5	19.2	19.2
Area of base, square inches	3.30	3.61	4.01
Per cent of total	41.7	40.7	40.6
Total area, square inches	7.91	8.87	9.85
Moment of inertia	25.1	32.3	41.3
Section modulus, head	9.38	11.45	13.70
Section modulus, base	11.08	13.21	15.74
Ratio periphery to area, head	1.79	1.68	1.64
Ratio periphery to area, web	3.57	3.65	3.60
Ratio periphery to area, base	2.72	2.58	2.49
Ratio periphery to area, total	2.53	2.42	2.37

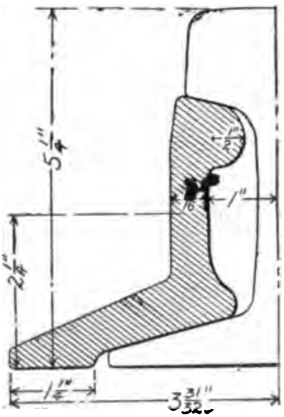
Each series included designs for 60 and 70-pound rails. The sections provide for a larger proportion of metal in the base than in the head. The Series A sections have greater moments of inertia than those of Series B and are also stiffer. In the design of the former the girder function of the rail and its ability to distribute the load over a number of supports was emphasized.

CHAPTER IV.

Standard Rail Joints

The design of a rail joint, which is to fulfill the requirements of service, is by no means an easy problem. To produce at the joint the effect of a continuous rail and to have the joint both durable and economical in first cost as well as cost of installation, are a few conditions upon which the design must depend. There are in use today a large number of different designs, varying in length, cross-section and spacing of bolts and these are described briefly in the following paragraphs.

The angle bar is the most common design of joint. In the accompanying illustrations several cross-sections

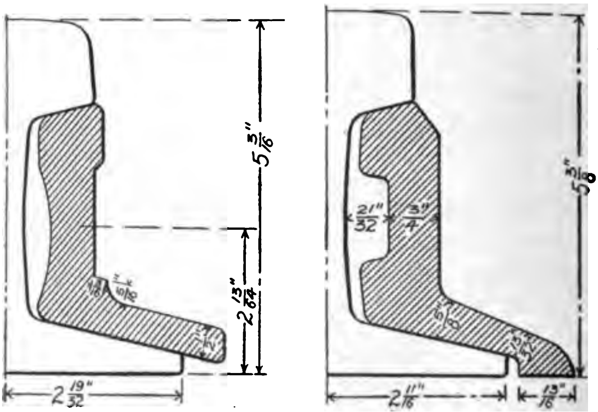


Section of C. R. R. of N. J. Rail Joint.

of angle bars in use on American railroads are shown. The angle bars illustrated are not designed for the same weight of rail, but the drawings indicate the variation in section. It will be noted that there is in all cases a maximum bearing surface between bar and rail, allowance being made, of course, for wear of the joints. The amount of metal at the top is greater than that at the middle and in some cases there is a marked difference. The purpose is to strengthen the joint where the stresses are excessive. The section is decreased near the middle, affording a saving in metal.

The angle bar is also used in combination with a base plate, extending the length of bar. This combination affords a joint of greater strength because the base plate gives a larger and better bearing surface to the rail.

Instead of the angle bar and base plate, the continuous joints may be used. In a simple form it consists of two pieces, combining the base plate with the angle bar

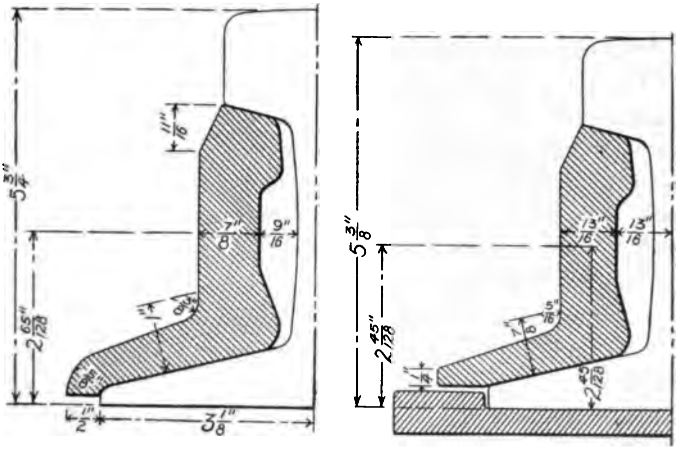


Sections of C. B. & Q. and C. R. R. of N. J. Rail Joints.

and leaving a clearance of about ½ inch between the two halves of the base plate. In another form, base plate is made separate and bears at the sides upon short projections of the splice bar. The latter form is a patented joint, termed the Wolhaupter.

Another form of joint in use is the reinforced joint which consists of angle bars having deeper sections about 5 ins. on each side of the center line of joint. The projection extends down below the rail between the ties. It serves to give additional strength and solidity at the center of joint. Two designs of this form are the Duquesne and 100 per cent splice bars, both of which are used on the Pennsylvania Lines. The Bonzano joint is similar to the above. In the latter the section of metal is the same throughout, but the central section of he flange is bent vertically downward between the ties.

The general requirements of the standard rail joint,



Sections of B. & O. and C. St. P. M. & O. Rail Joints.

which were adopted by the American Railway Engineering and Maintenance of Way Association, are as follows:

(1) It should connect the rails into uniform continuous girder.

(2) It should be strong enough to resist deformation or taking permanent set.

(3) It should prevent deflection or vertical movement of the ends of the rails and permit movements lengthwise for expansion.

(4) It should be as simple and of as few parts as possible to be effective.

(5) Finally, its cost must not be prohibitive.

In the accompanying tables for 4 and 6-hole rail joints, the length of joint, spacing of spike holes, spacing of bolt holes and distance between rail ends are given.

Short rail joints are usually 24 or 26 ins. long and have 4 bolt holes. As is shown by the table, there is not much similarity in the spacing of bolt holes.

The long rail joints are from 28 to 40 ins. in length and have 6 bolt holes. The spacing of bolt holes for these joints also varies greatly. The recommendation for standard drilling of rails, adopted by the American Railway Engineering and Maintenance of Way Association, calls for a distance of 5 ins. between holes, but it is shown that in only one case does the spacing conform to this recommendation.

BALTIMORE & OHIO RAILROAD.—The 6-hole angle bars for 85 and 100-lb. rails are 28 ins. long. The diameter of holes is 1⅛ ins. and the oblong holes are 1½ ins. wide. Round and oblong holes alternate. Diameter of bolts is 1 in. The clearance between 60-ft. rails is 5-16

in. and clearance between 33-ft. rails is 3-16 in. The slots in angle bars are made ¾ in. wide and just deep enough to bring the spike against the base of rail. The 4-hole angle bars for 85 and 100-lb. rails are 26 ins. long. The oblong bolt holes are made 1 5-16 ins. wide.

Central Railroad of New Jersey. The 6-hole angle bar for 85-lb. rail is 30 ins. long. The diameter of round holes is 1 in., oblong holes being 1 5-16 ins. wide. Round and oblong holes alternate. Bolts are ⅞ in. in diameter. Spike holes are ¾ in. wide.

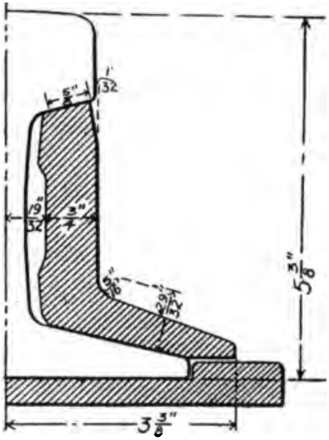
The 6 hole angle bar for 90-lb. rail is 28 ins. long. Round holes are 1 1-16 ins. in diameter and oblong holes 1 5-16 ins. wide. Bolts are ⅞ in. in diameter.

Cincinnati Northern Railroad.—The 4-hole angle bar for 70-lb. rail is 24 ins. long. The round holes are of 1 in. diameter and width of oblong holes is 1¼ ins. Bolts are of ⅞ in. diameter. Spike holes are 11-16 in. wide and ⅝ in. deep. Oblong and round bolt holes alternate.

Chicago & Alton Railway.—The 6-hole angle bar for 80-lb. rail is 29 ins. long. The diameter of round bolt holes for inside angle bars is 1 in. and for outside angle bars the width of oblong hole is 1¼ ins. Bolts of ⅞ in. diameter are used. The spike holes are 13-16 in. wide and ¾ in. deep. Weight per pair of angle bars is 55.7 lbs. A standard 29-in. Weber joint is also used.

Chicago & Northwestern Railway.—The 4-hole joint for 90-lb. rail is 26 ins. long. Oblong bolt holes are used, being 15-16x1 5-16 ins. The bolts are 13-16 in. in diameter. Spike holes are 1 in. wide and ¾ in. deep.

Chicago & Western Indiana Railroad.—The 6-hole



Section of C. & N. W. Rail Joint.

angle bars for 80-lb. rail are 36 ins. long. The bolt holes are 15-16x1¼ ins. Spike holes are ¾ in. wide. Bolts of ⅞ in. diameter are used.

CHICAGO, ROCK ISLAND & PACIFIC RAILWAY.—The 4-hole angle bar for 85-lb. rail is 26 ins. long. Round bolt holes are 1⅛ ins. diameter and elliptical holes are 1 1-16 high, 1⅜ ins. wide. Round and elliptical holes alternate. Spike holes are ¾ in. wide and 13-16 in. deep. A base plate is shown on the drawing.

This base plate is also used where it is necessary to reinforce joints on lighter rail sections and the punching conforms with that of the angle bar used.

CHICAGO, ST. PAUL, MINNEAPOLIS & OMAHA RAILWAY.—The 4-hole angle bars for 80 and 90-lb. rail are 24 ins. long. Round bolt holes are of 1 in. diameter and oblong holes are 1 5-16 ins. wide. Round and oblong holes alternate. Bolts are of ⅞ in. diameter. Spike holes are

¾ in. wide and 13-16 in. deep. Base plates are shown on the standard drawings.

Delaware & Hudson Company.—The 6-hole angle bar for 90-lb. rail is 30 ins. long. Round bolt holes are of ⅞ in. diameter and oblong holes are ⅞x1⅛ ins. One angle plate of a pair has round holes and the other oblong holes. Spike holes are ¾ in. wide and ¾ in. deep.

Denver & Rio Grande Railroad.—The 4-hole angle bar for 85-lb. rail is 26 ins. long. Round bolt holes are of 1-in. diameter and oblong holes 1¼ ins. wide. Round and oblong holes alternate. Spike holes are ⅝ in. wide and 25-32 in. deep. The weight of a pair of bars is 51.4 lbs.

Chicago, Burlington & Quincy Railroad.—The 6-hole angle bar for 100-lb. rail is 36 ins. long. Round bolt holes are 1 1-16 ins. in diameter and oblong holes are 1 5-16 ins. wide. Round and oblong holes alternate. Spike holes are ¾ ins. wide. Bolts of 1 in. diameter are used.

The 6-hole angle bar for 85-lb. rail is 35½ ins. long. Round bolt holes are 15-16 ins. in diameter and oblong holes are 1 3-16 ins. wide. Round and oblong holes alternate. Spike holes are ¾ in. wide. Bolts of ⅞ in. diameter are used.

The 4-hole, 24-in. continuous joint for 90-lb. rail has 1 5-16 in. bolt holes and for 85-lb. rail it has 1 1-16 in. bolt holes.

Grand Rapids & Indiana Railway. — The 4-hole angle bar for 85-lb. rail is 26 ins. long. Round bolt holes are 1⅛ ins. diameter and oblong holes are 1⅜ ins. wide. Inside angle bar has oblong holes and outside has round

holes. Bolts are of 1-in. diameter. Spike holes are 11-16 in. wide and ¾ in. deep.

Great Northern Railway.—The 4-hole angle bar for 85-lb. rail is 24 ins. long. Round bolt holes are of 1-in. diameter and oblong holes 1 5-16 ins. wide. Round and oblong holes alternate. Spike holes are 11-16 in. wide and 9-16 in. deep. A Wohlhaupter rail joint is also used.

Harriman Lines.—The 4-hole improved angle bar for 90-lb. rail is 27 ins. long. Bolt holes are 1x1¼ ins. Spike holes are 13-16 in. wide. Weight per pair is 67.32 lbs. The 27-in. Continuous joints weigh 43.0 lbs. each.

Illinois Central Railroad.—The 6-hole angle bar for 85-lb. rail is 40 ins. long. Round bolt holes are 1 5-32 ins. in diameter. Spike holes are 11-16 in. wide and ½ in. deep. The weight per pair is 80 lbs.

Intercolonial Railway.—The 4-hole angle bar for 80-lb. rail is 24 ins. long. Oblong bolt holes are 15-16 x1¼ ins. Spike holes are ¾ ins. wide and 27-32 in. deep.

Kansas City, Mexico & Orient Railway. — The 4-hole angle bar for 70-lb. rail is 26 ins. long. Oblong bolt holes are ⅞x1⅛ ins. Bolts are of ¾ in. diameter. Spike holes are ¾ in. wide and ⅝ in. deep. Weight of angle bars per pair is 43.3 lbs.

Lehigh Valley Railroad.—The 6-hole angle bar for 90-lb rail is 28 ins. long. Oblong bolt holes are 15-16x 1 3-16 ins. Spike holes are ¾ in. wide and ¾ in. deep. The weight per pair of angle bars is 59½ lbs.

Michigan Central Railroad.—The 4-hole angle bar for 80-lb. rail is 25 ins. long. Round bolt holes are of 1-in. diameter and oblong holes are 1¼ ins. wide. Round

and oblong holes alternate. Spike holes are ⅝ in. wide and ¾ in. deep.

The 6-hole angle bar for 100-lb. rail is 38 ins. long. Round bolt holes are of 1⅛-in. diameter and oblong holes are 1⅜ ins. wide. Round and oblong holes alternate. Spike holes are ⅝ ins. wide and 13-16 in. deep.

MISSOURI PACIFIC RAILWAY. — The 4-hole angle bar for 85-lb. rail is 26 ins. long. Round bolt holes are of 1 1-16-ins. diameter and oblong holes are 1 7-16 ins. wide. Round and oblong holes alternate. Bolts are of 1-in. diameter. Spike holes are 11-16 in. wide and 25-32 in. deep.

NEW YORK CENTRAL & HUDSON RIVER RAILROAD.— The 6-hole angle bar for 80-lb. rail is 36 ins. long. Round bolt holes are 1-in. diameter and square holes measure 15-16 in. Round and square holes alternate. Spike holes are 11-16 in. wide and 9-16 in. deep. Weight of angle bars per pair is 64.5 lbs.

The 6-hole angle bar for 100-lb. rail is 36 ins. long. Round bolt holes are 1-in. diameter and square holes measure 1 1-16 ins. Weight of angle bars per pair is 80 lbs.

NEW YORK, NEW HAVEN & HARTFORD RAILROAD.— The 4-hole angle bar for 100-lb. rail is 24 ins. long. Round bolt holes are 1-in. diameter and oblong holes are 1 3-32 ins. wide. Round and oblong holes alternate. The four spike slots are ¾ in. wide and 15-16 in. deep.

PENNSYLVANIA LINES WEST OF PITTSBURGH. — The 6-hole angle bar for 100-lb. rail are 33 ins. long. Round bolt holes are 1 1-16 ins. in diameter and oblong bolt holes are 1 1-16x1⅜ ins. Spike holes are 11-16 in. wide

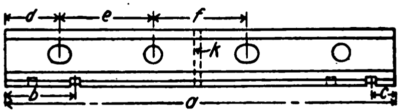


Diagram No. 1.

and ¾ in. deep. Among the standard rail joints are the Duquesne splice bar, 100 per cent splice bar and Bonzano splice bar. This refers to angle bars for A. S. C. E. section rail.

The 6-hole angle bars for P. S. section rail are 30 ins. long. Spike holes are 1¼ in. deep, but otherwise same as for A. S. C. E. section rail.

PERE MARQUETTE RAILROAD.—The 4-hole angle bar for 85-lb. rail is 23 ins. long. Round bolt holes are 1⅛ ins. in diameter and oblong holes are 1⅜ ins. wide. Round and oblong holes alternate. Spike holes are ⅝ in. wide and 25-32 in. deep.

PHILADELPHIA & READING RAILWAY.—The 6-hole angle bar for 90-lb. rail is 28 ins. long. Round bolt holes are 31-32 in. in diameter and oblong holes are 31-32x1 5-16 ins. Round and oblong holes alternate. Spike holes are ¾ in. wide and 1 in. deep.

WABASH RAILROAD.—The 4-hole angle bar for 80-lb. rail is 24 ins. long. Round bolt holes are 1 in. in diameter and oblong holes are 1¼ ins. wide. Round and oblong holes alternate. Spike holes are 11-16 in. wide.

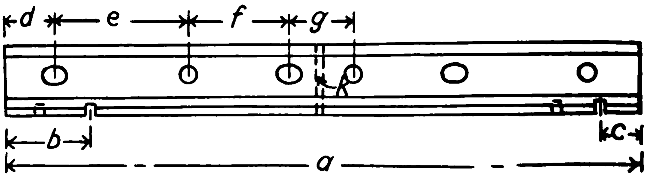


Diagram No. 2.

Specifications for Standard Rail Joints

TABLE NO. 1—FOUR-HOLE ANGLE BARS.

Railroad—	a	b	c	d	e	f	k
B. & O.	26	4	2	5	5	6	3/16
C. R. R. of N. J.	24	5	1 9/16	3	6	6	1/8
Cin. North	24	5½	3½	4 15/16	5	4⅛	1/8
C. & N. W.	26	5 13/16	2 9/16	4	6	6	3/16
C., R. I. & P.	26	2½	6	3 15/16	6	6⅛	1/8
C., St. P., M. & O.	24	5 7/16	2 1/16	3	6	6	3/16
D. & R. G.	26	5 11/16	1 5/16	4 1-32	6	5 15/16	1/8
G. R. & I.	26	5⅝	2 3/16	3 29/32	6	6 3/16	3/16
G. N.	24	3½	2	4½	5	5	1/8
Harriman Lines	27	6⅞	3⅝	5¼	5½	5½	1/8
I. C. Ry.	24	4 11/16	1 5/16	3	6	6	1/8
K. C. M. & O.	26	5⅝	1⅞	5¼	5½	4½	1/4
M. C. R. R.	25	4 7/16	1 9/16	3½	6	6	..
Mo. Pac.	26	4	2	5½	5½	5	3/16
N. Y. N. H. & H.	24	4⅜	1⅜	2½	7	5	1/4
Pere Marquette	23	5 5/16	1 13/16	3	6	6	..
P. & R.	24	5	1 9/16	3	5	8	1/8
Wabash	24	6½	2½	4	5	5	..

NOTE—See Diagram No. 1 for Interpretation of Letters.

TABLE No. 2—SIX-HOLE ANGLE BARS.

RAILROADS.	a	b	c	d	e	f	g	k
B. & O.	28	5½	3½	2½	5½	4	4	3/16
C. R. R. of N. J. (90 lb.).	28	6½	2	3	5	4	4	1/8
C. & A.	29	5 31/32	4 17/32	3	4½	4½	5	3/16
C. & W. I.	36	11	7	3½	6	6	5	1/8
C. B. & Q. (100 lbs.)	36	2¼	2¼	4½	5	5	5	3/16
D. & H.	30	6 15/16	5 7/16	3 31/32	4 15/32	4 15/32	4 3/16	3/16
Har. Lines	29	5 31/32	4 17/32	3	4½	4½	5	3/16
I. C. R. R.	40	...	...	4¼	9	4½	4½	3/32
L. V. R. R.	28	6	2	4	4	4	4	3/32
M. C. R. R.	38	4⅞	2⅛	3	8	6	4	..
N. Y. C. & H. R.	36	5 9/32	2 23/32	4	5 3-5	5 3-5	5 3-5	1-10
P. L. W. of P.	33	7	5	3	6	5	5	3/16
P. L. W. of P. (P. S. type)	30	6½	3½	2	6	4½	5	3/16
P. & R.	30	6½	2	4	5	4	4	1/8

Note.—See Diagram No. 2 for Interpretation of Letters.

CHAPTER V.

Rigid and Spring Rail Frogs

Rigid frogs from No. 8 to and including No. 10 are generally used. A No. 8 is usually 12 ft. long and a No. 9 or 10 is 15 ft. long. Frogs below No. 8 are made 8, 10 or 12 ft. long. Nos. 12, 14 and 16 are about 20 ft. long; No. 18 is 24 ft. long. The Erie Railroad has a No. 20 frog which is 27 ft. 6 ins. long, with special steel anvil-faced points and wing rails, weighing altogether about 2,500 lbs. This frog has to be handled by a crane. The Pennsylvania Railroad has a No. 20 frog which is only 20 ft. long, the hard steel heel block replacing the inside angle bars of the joint at the heel.

The best rigid frog is usually of the bolted type with wrought iron fillers between wing and point rails. The wing rails are attached with clips to a single plate 6 to 12 ft. in length, according to length of frog, or to tie plates, the former being better practice, and the point rails are riveted together. It is not necessary to rivet rails to tie plates. Where a single plate is used, fillers between wing and point rails and bolts are sometimes omitted, all rails being simply riveted to plate and point rails riveted together. This latter construction is not usually used with modern heavy equipment.

At each side of the throat of the frog it is customary to bolt wing rails through a cast iron filler. There should be no bolt through the bend of the throat, as this would weaken it. All other fillers should be of wrought iron

or rolled steel. Between point rails an inclined heel riser is located and bolted to rails. This heel block should be of hard cast steel and not an inverted rail section. There should be wooden or iron foot guards in throat and heel of all frogs.

The width of flangeway is either 1¾ ins. or 1⅞ ins. The majority of roads specify a 1¾-in. flangeway. The width of throat varies between 1¾ ins. and 2½ ins., giving an average of about 2 ins.

Standard Rigid Frogs

CENTRAL RAILROAD OF NEW JERSEY.—The standard No. 8 rigid frog is 12 ft. long and 7 ft. 1½ ins. from heel to actual point. The distance between actual and theoretical points is 4½ ins.

The standard No. 10 frog is 15 ft. long and 8 ft. 6⅜ ins. from heel to actual point. The distance between actual and theoretical points is 5⅝ ins.

The point rails are bolted to wing rails through cast iron filler with 1⅛ in. bolts for 80-lb. rails and above and with 1-in. bolts for rails under 80 lbs.

The point and wing rails are riveted to a ¾x16 in. plate with ⅞-in. rivets, countersunk in bottom of plate. The width of flangeways is 1⅞ ins. and width at throat is 2¼ ins.

The standard special steel rigid frogs of sizes No. 6 to 15 inclusive have a steel center casting to which the wing rails are bolted. With the No. 8 frog, the casting is 7 ft. 7 ins. in length, the distance from point to heel end of casting being 4 ft. 11½ ins.

CHICAGO & ALTON RAILWAY.—The standard No. 10

rigid frog has a total length of 15 ft. and is 8 ft. from heel to ½-in. point, the distance between actual and theoretical points being 5 ins. The width of flangeway is 1⅞ ins. The wing rail is 11 ft. 4 ins. long, the long point rail is 8 ft. and the short point rail is 6 ft. 4 ins.

The wing and point rails are bolted through a wrought iron filler with 1⅛-in. bolts, the weight of rail being 80 lbs. The wing rails are riveted to plate, ¾x16x22 ins. by 4 ft. 3 ins., with ⅞-in. rivets. The point rails are riveted with ⅞-in. rivets. An inverted old steel rail is used for the heel riser.

CINCINNATI, HAMILTON & DAYTON RAILWAY.—The standard rigid frogs have 1¾-in. flangeways and 1¾-in. throats.

The point and wing rails are bolted through rolled steel or rolled iron fillers with 1⅛-in. bolts for rails of 85 lbs. or greater and with 1-in. bolts for rails of less than 85 lbs.

The center of first bolt through point rail is 2 15-16 ins. back of actual point, the spacing of bolts being 5½ ins. Wing rails are bolted with an additional bolt 2 9-16 ins. ahead of point. The fillers are solid and continuous, extending at least 4 ins. ahead of point and at least 2 ins. back of center of last bolt. The fillers fit the rail section, are cut to fit over rivet heads and are notched at point to form shoulder for the point.

Point rails are riveted together with at least two ⅞-in. rivets. Frogs of Nos. 12 to 20 inclusive have two additional rivets, one where rail heads join and other between this rivet and last bolt.

Under the point there is an 8x⅝ in. by 1 ft. 4 in.

plate, to which the wing rails are riveted with ¾-in. rivets.

Frog No. 8 has a total length of 11 ft. 5 ins., the distance from heel to point being 6 ft. 11 ins.; frog No. 10 has a total length of 13 ft. 7¾ ins., the distance from heel to point being 8 ft. 4 ins., and frog No. 12 has a total length of 18 ft., the distance from heel to point being 10 ft.

CHICAGO, MILWAUKEE & ST. PAUL RAILWAY.—The standard filled frog for 75-lb. rail has a total length of 9 ft., has a spread at heel of 8½ ins., has an angle of 8 degs., and is 4 ft. 11 ins. from heel to point, the distance between actual and theoretical points being 1¾ ins. The width of flangeway is 1⅞ ins. The wing and point rails are bolted together through fillers and point rails are riveted together.

CHICAGO, ROCK ISLAND & PACIFIC RAILWAY.—The rigid frogs herein described, have 1¾-in flangeways and 1¾-in throats. The wing and point rails are bolted through a rolled steel filler with 1⅛-in. bolts for rails of 75 lbs. or more. The point rails are riveted with ⅞-in. rivets. Special tie plates are used under frogs on all soft wood switch ties, on all treated switch ties and on all white oak switch ties where there is heavy traffic.

Cast iron fillers are used between wing rails, at throat and between heel riser and point rails.

The No. 10 rigid frog is 15 ft. long and 8 ft. 4 ins. from heel to point. The No. 15 rigid frog is 20 ft. long and 12 ft. long and 12 ft. 6 ins. from heel to point.

DELAWARE & HUDSON COMPANY.—The standard rigid frogs have two piece fillers between wing

and point rails. The point rails are riveted together. The frog rests on 5/8-in. plates to which the point rails are fastened by means of special angle bars, riveted or bolted to the base plate.

The No. 6 rigid frog is 9 ft. long and 6 ft. from heel to theoretical point; the No. 8 frog is 11 ft. long and 6 ft. 10½ ins. from heel to theoretical point; the No. 9 frog is 12 ft. long and 7 ft. 10½ ins. from heel to theoretical point, and the No. 12 frog is 15 ft. long and 9 ft. from heel to theoretical point.

Denver & Rio Grande Railroad.—The rigid frogs are bolted through wing rails, filler and point rails with 7/8-in. bolts for rails of 52 lbs. or over and with ¾-in. bolts for rails under 52 lbs. The point rails are riveted with 7/8-in. rivets and wing rails are riveted to 5/8-in. plates of dimensions to suit frog. The width of flangeway is 1¾ ins. and width of throat is 1 7/8 ins.

The No. 7 frog is 15 ft. long and 7 ft. 6 ins. from heel to theoretical point, the distance between actual and theoretical points being 3½ ins.; the No. 8½ frog is 15 ft. long and 8 ft. 11 ins. from heel to theoretical point, the distance between actual and theoretical points being 4¼ ins., and the No. 10 frog is 15 ft. long and 9 ft. 2 ins. from heel to theoretical point, the distance between actual and theoretical point, being 5 ins.

Great Northern Railway.—The standard rigid frogs have a 1 7/8-in. flangeway. The wing and point rails are bolted through a rolled or cast steel filler with 1 or 1 1/8-in. bolts. The wing rails are riveted to ½x6-in. tie plates of various lengths with ¾-in. rivets.

The No. 7 frog is 12 ft. long and 7 ft. from heel to

point, the distance between actual and theoretical points being 3½ ins.; the No. 9 frog is 15 ft. long and 8 ft. from heel to point, the distance between actual and theoretical point being 4½ inches and the No. 15 frog is 20 ft. long and 12 ft. from heel to point, the distance between actual and theoretical points being 7½ ins.

HARRIMAN LINES.—The standard rigid frogs have

Railroad—	Frog No.	Length (feet)	Heel to Point (feet)	Width of Flange-way (inches)	Width at Throat (inches)	Length of Wing Rail (feet)
C. R. R. of N. J..	10	15	8 17/32	1⅞	2¼	10 9/24
C., H. & D......	10	13 31/48	8 1/3	1¾	1¾	....
C. & A..........	10	15	8	1⅞	...	11 1/3
C., M. & St. P..	7+	9	4 11/12	1⅞	...	7
C., M. & St. P..	10	11	6 7/12	1⅞	...	8
C., R. I. & P...	10	15	8 1/3	1¾	1¾	11
D. & H.........	9	12	7 1/2	...	...	....
D. & R. G......	10	15	8 3/4	1¾	1⅞	9
G. N............	9	15	8	1⅞	...	11 1/2
Har. Lines......	9	12	7 9/24	1¾	...	9 1/4
Inter-Col.	9	12	7 3/24	1¾	1¾	9 3/4
L. V............	10	15	9 1/12	1⅞	2½	10 1/3
N. Y., N. H. & H.	10	15	9 7/12	1¾	2¼	....
N. Y. C. & H. R.	10	15	9 1/24	1⅞	2¼	10 1/4
P. L. W. of P...	10	15	8 1/2	1¾	...	....
Pere Marquette..	8	12	7 7/12	1¾	...	8 1/2
Phila. & Read...	8	15	8 5/6	1¾	2	11

1¾-in. flangeways. The wing and point rails are bolted with 1⅛-in. bolts through wrought iron fillers. The point rails are riveted with ⅞-in. rivets.

The No. 6 frog is 9 ft. long and 5 ft. 9 inches from heel to theoretical point, the wing rails being 7 ft. 1 in. in length, the No. 7 frog is 10 ft. long and 6 ft. 6 ins. from heel to theoretical point, the wing rail being 8 ft. 1 in. in length; the No. 9 frog is 12 ft. long and 7 ft. 9 ins. from heel to theoretical point, the wing rails being 9 ft. 3 ins. in length, and the No. 14 frog is 18 ft. long and 11 ft. 10 ins. from heel to theoretical point, the wing rails being about 12 ft. 6 ins. in length.

INTERCOLONIAL RAILWAY.—The standard frogs are riveted to plates and straps with ¾ and ⅞-in. rivets. The point rails are riveted with ⅞-in. rivets.

The No. 9 frog for 80-lb. rails is 12 ft. long and 7 ft. 1½ ins. from heel to point with 10 ins. spread at heel, the distance between actual and theoretical points being 4½ ins. A cast iron block is used at heel between wing and point rails which are held by a ¾x3-in. strap. The casting at point is 16 ins. long and is riveted to plate. Castings are also used at throat between rails and also between rails and a ⅞x4-in. wrought iron strap, a 1-in. bolt passing through strap, fillers and rails. The bottom wrought iron plate is ¾-in. thick and 5 ft. long.

LEHIGH VALLEY RAILROAD.—The standard rigid frogs have 1⅞-in. flangeway and 2½-in. throat. Bolts for 67-lb. rail are 1-in.; for 80 and 90-lb. rail, 1⅛ in., and for 100-lb. rail 1¼ in. Point rails are riveted with 1⅛-in. countersunk rivets. Three wrought iron tie-plates, ¾x6 ins., are used with the frog and these are riveted

to wing rails with exception of plate at the point. Fillers are of rolled steel and cast iron.

The No. 10 frog is 15 ft. long and 9 ft. 1 in. from heel to point, the distance between actual and theoretical points being 5 ins.; the No. 12 frog is 18 ft. long and 11 ft. from heel to point, the distance between actual and theoretical points being 6 ins.

NEW YORK CENTRAL & HUDSON RIVER RAILROAD.—The standard rigid frogs have 1⅞-in. flangeways and 2¼-in. throats. Bolts are ⅞ in. for 70-lb. rail, 1-in. for 75-lb. rail, 1⅛ in. for 80-lb. rail and 1¼ in. for 100-lb. rail. Fillers are of cast iron or cast steel and are of two pieces between wing and point rails. Point rails are bolted together and frog is bolted to a ¾-in. steel plate, which in case of No. 10 frog is 6 ft. 6 ins. long and 1 ft. 9 ins. wide. The distance from heel to steel incline heel block is made less than 1 ft. 6½ ins.

The No. 6 rigid frog is 10 ft. long and 6 ft. 3 ins. from heel to point, the distance between actual and theoretical points being 3 ins. and the No. 10 frog is 15 ft. long and 9 ft. ½ in. from heel to point, the distance between actual and theoretical points being 5 ins.

NEW YORK, NEW HAVEN & HARTFORD RAILROAD.—The rigid frogs have a 1¾-in. flangeway and a 2¼-in. throat. The frog for 68-lb. rail has 1-in. bolts and rivets and for 90-lb. rail 1⅛-in. bolts and rivets. Point rails are riveted together. When tie-plates are used for bearing, they are ¼x6 ins., and are of various lengths. Fillers are used between point and guard rails.

The No. 7 frog is 10 ft. 6 ins. long and 7 ft. from heel to theoretical point; the No. 8 frog is 12 ft. long and 8

ft. from heel to point, and the No. 10 frog is 15 ft. long and 10 ft. from heel to theoretical point.

PENNSYLVANIA LINES WEST OF PITTSBURG.—The standard rigid frogs have 1¾-in. flangeways. The wing and point rails are bolted through a filler with 1-in. bolts for rails less than 85 lbs., and with 1⅛-in. bolts for rails of 85 and 100 lbs. The point rails are riveted with ⅞-in. rivets. The point of the frogs rests on a ⅝x8-in. tie-plate to which frog is riveted. The length of this plate to be sufficient to allow two spike holes on the outside of each wing rail.

In the toe of the frog and at the flare on heel end of wing rails ⅜-in. by about 2½-in. steel bands of various lengths are bolted to wing rails, and these bands fill the purpose of foot guards.

The No. 10 rigid frog is 15 ft. long and 8 ft. 6 ins. from heel to point; the No. 15 frog is 20 ft. long and 12 ft. from heel to point; and the No. 20 frog is 27 ft. long and 17 ft. 6 ins, from heel to point.

PERE MARQUETTE RAILROAD.—The No. 8 rigid frog is 12 ft. long and 7 ft. 7 ins. from heel to point. The width of flangeway is 1¾ ins. The frogs are bolted through filler with 1-in. bolts. The spread at heel is 10⅝ ins.

PHILADELPHIA & READING RAILWAY.—The standard bolted and stiff rail frogs have 1¾-in. flangeways and 2⅛-in. throats for frogs up to and including No. 6, and 2-in. throats for frogs above No. 6. The frogs are bolted with 1⅛-in. bolts and wing rails are riveted to wrought iron or rolled soft steel tie-plates with ½-in. rivets. The point rails are held together with ¾-in. rivets. The fill-

ers between wing and point rails at point are of wrought iron and beyond points of cast iron. A cast iron filler is used between wing rails at throat.

Standard frogs, Nos. 3 to 11 inclusive, are 15 ft. long and 8 ft. 10 ins. from heel to point, the wing rails being 10 ft. long for Nos. 3 to 5 inclusive and 11 ft. for Nos. 6 to 11 inclusive; frogs Nos. 12 to 16 inclusive are 20 ft. long and 12 ft. from heel to point, the wing rails being 14 ft. 5 ins. long and the No. 20 frog is 26 ft. long and 16 ft. from heel to point with wing rails 17 ft. long.

Of the many devices used with spring rail frogs, a few are illustrated herewith. Opinions as to the value of the devices designed for the same purposes are, of course, at variance. They should be simple above all things, durable and absolutely sure in action.

The design of spring which is used most extensively consists of two boxed coils, one on each side of frog, with a bolt rod passing through frog and springs. This spring is located either ahead of or back of the point. When ahead of the point, it should be placed in the throat of the frog where the wing rails are parallel to each other; when back of the point it is from 12 to 20 ins. from the point. This style of spring is the best practice and is much better located in the throat of the frog. In the case of a very long wing rail its action is supplemented by an auxiliary box spring on the outside of movable rail near the heel in combination with a hold-down device. Another design consists of a spring on the side opposite the spring rail and connected to it by a rod, passing under the rails and fastened to the reinforcing plate of the spring rail. A third design consists of two boxed springs located at side of spring rail which is operated by means of hinged arms. These last two designs, however, are rapidly becoming obsolete.

The anti-creeper prevents movements of spring rail with relation to fixed rails of the frog, and thereby keeps the spring from binding and checking the movement of the spring rail. One of the devices used for this purpose is a toe block, Fig. 7. A second device

consists of a strap bolted to the spring and turnout rails at the mouth of the frog, Fig. 4. A third device (Fig. 3) consists of a pivoted arm in the mouth of the frog, the arm being attached to the fixed wing rail and the spring wing rail by clamps and bolts. Fig. 6 shows a fourth method of preventing creeping by means of a hinge rail attached to the main rail by a bolt hinge and to movable part of spring rail by bolts. Other devices consist of one or two hinged links on spring rail side and are in combination with spring or hold-down devices. Fig. 5 shows a combination anti-creeper, hold-down and stop, used largely on a form of yard frog, having two movable wing rails with no springs which gives solid crossing for the wheels on either track.

The hold-down devices for the spring rail usually act as stops. A common hold-down device consists of a guide box and a bar or lug projecting from the spring rail. Instead of the separate bar a better way is to bend the reinforcing strap out to form projections, as in Fig. 1, which slide in the guide boxes. In most cases two of these devices are employed, one near the outer end of the movable rail and one near the point. In combination with two of the devices described above, a plate and rod are sometimes used at the outer end, the rod passing through the spring rail and riveted or bolted to the point rails. Another method of holding down the rail is to rivet the spring rail to a plate at the outer end. Another device consists of a hinged arm combination anti-creeper and hold-down.

Besides the hold-down devices there are from one to five other stops used for the spring rail. Various de-

signs of rail braces are used, the braces being cast with the tie-plate, or riveted or bolted to it. Tie-plates are also bent up at the ends to form stops for the base of the spring rail.

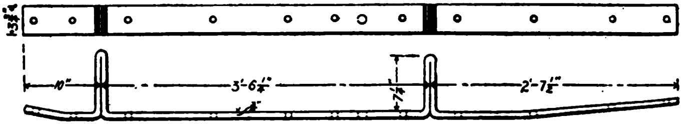
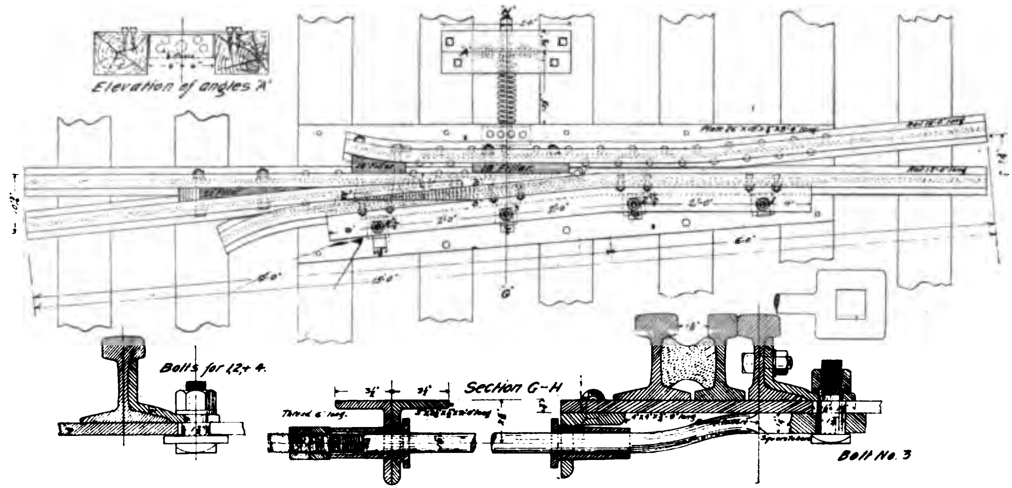


Fig. 1. Reinforcing Bar.

A spring rail frog for the best standard practice should preferably have a reinforcing bar and hold-down as shown in Figs. 1 and 8, stops like that in Fig. 11, pivoted arm anti-creeper as in Fig. 3. The springs should be at the throat, of the form shown in Fig. 2, backed up, in the case of a very long spring rail, by an auxiliary box spring near the outer end. The fixed rails should be riveted to a long single plate and there should be cast or rolled steel fillers with bolts between the fixed wing and point rails and a hard steel heel block between the point rails. No frog of greater number than a No. 12 should be made with movable spring rail.

Central Railroad of New Jersey.—The standard No. 10 spring rail frog is 15 ft. in length and 8 ft. 6⅜ ins. from heel to actual point. The frog has a 1⅞-in. flangeway and a 1⅞-in. throat. The frog is riveted to a 26x18x¾-in. plate 8 ft. 4 ins. long. The fixed wing rail is 10 ft. long and the spring rail is 12 ft. long. The spring rail is planed down so that badly worn flanges may easily ride over the spring rail without moving it. The standard double coil spring is located about 12



Central Railroad of New Jersey Spring Rail Frog.

ins. back of the point and on the side opposite the spring rail. The spring bolt is fastened to an angle plate, which plate is bolted to the spring wing rail and reinforces it. This angle plate is ½ in. thick, is bent to fit web and flange of rail, is about 6 ins. wide and about 7 ft. 6 ins. long. The motion of this angle plate, together with spring rail, is controlled by guides which move in rectangular openings in the base plate to which the frog is secured. The angle plate serves to reinforce the spring rail, to hold down the spring rail and to prevent creeping of the spring rail.

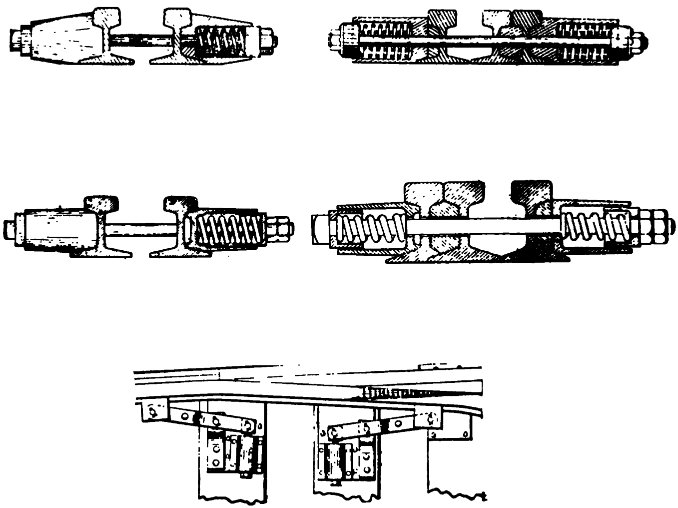


Fig. 2. Springs.

Chicago & North-Western Railway.—The standard No. 10 spring rail frog is 15 ft. long and 8 ft. 6 ins.

from heel to theoretical point. The width of flangeway and throat is 2¼ ins. Seven base plates are used. Both spring rail and short point rail have a ¼-in. groove to permit passage of badly worn flanges.

The spring rail is reinforced with a bar fitting the ball and flange of rail and extending out 1⅛ ins. from head of rail. The reinforcing bar is flush with top of spring rail, from heel to the theoretical point, and is ¼ in. below top of spring rail from opposite theoretical point to toe of frog.

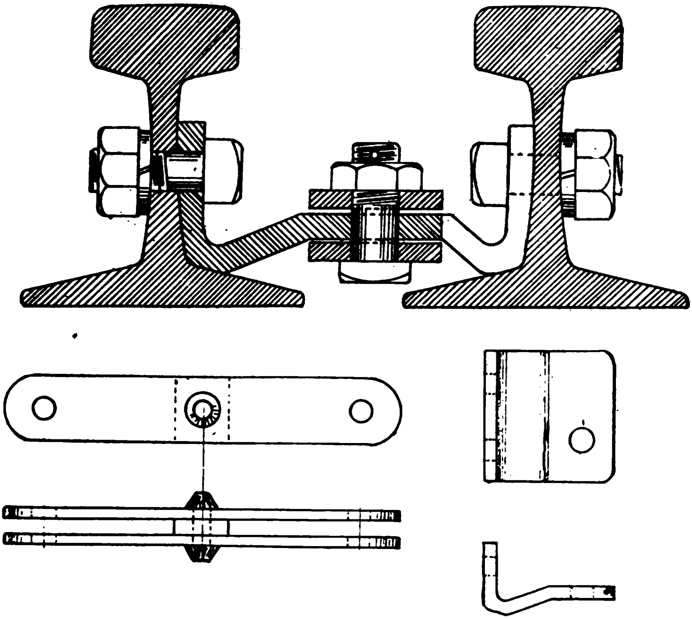


Fig. 3. Anti-Creeper with Detail Views Drawn on One-Half Scale.

The spring is located about 12 ins. back of the point. It is similar in design to the upper right-hand drawing in Fig. 2. Five base plates, of ⅜-in. iron and 4 ins. wide, have ends turned up to form stops for base of spring rail. The design is shown in Fig. 14. Two hold-downs also act as stops for the spring rail.

Two hold-downs are similar in design to Fig. 8 with the exception that a bar, ½x2¼ ins., is riveted to the reinforcing bar. There is also a hold-down placed in the heel of frog and it is similar to the design shown in Fig. 10, with the exception that the plate and rod are made in one piece and that the rod is bolted at its end to the point rail. The anti-creeper in the mouth of frog consists of a cast iron anchor block.

CHICAGO, BURLINGTON & QUINCY RAILROAD.—The standard No. 11 spring rail frog for 90-lb. rail is 19 ft. 4 17/32 ins. long and is 9 ft. 8 11/32 ins. from heel to theoretical point. The frog has a 1¾-in. flangeway and a 1¾-in. throat. Thirteen tie-plates are used. The spring rail is planed down ½ in. below frog.

Two reinforcing plates are riveted to the spring rail, one on outside being similar to bar shown in Fig. 1. The spring is located 4 ins. ahead of point and is of special construction, being outside of spring rail with

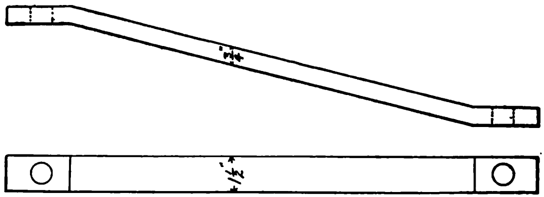


Fig. 4. Anti-Creeper Plain Strap.

springs acting at right angles to rail inside of barrel riveted to plate.

Two hold-downs are used in connection with reinforcing bar and are similar in construction to the design shown in Fig. 8. One brace is used ahead of point and an anchor block in mouth of frog.

CHICAGO, MILWAUKEE & ST. PAUL RAILROAD.—The standard No. 10 bolted spring rail frog is 15 ft. long and 7 ft. 2 ins. from heel to point. Four base plates are used. Both the spring and short point rails are planed ¼ in. to permit passage of badly worn flanges.

A ¾-in. reinforcing bar, 8 ft. long, is bolted to the spring rail. The spring is located ahead of the point of frog. Two base plates have ends turned, as shown in Fig. 14, to form stops for base of spring rail. Two holding-down devices similar to Fig. 8 are used. An anchor block is used in mouth of frog.

CHICAGO, ROCK ISLAND & PACIFIC RAILWAY.—The standard No. 10 spring rail frog is 15 ft. long and 8 ft. 4 ins. from heel to point. Nine base plates are used. The spring rail is planed down to allow passage of badly worn flanges.

The reinforcing bar for spring rail is of the design

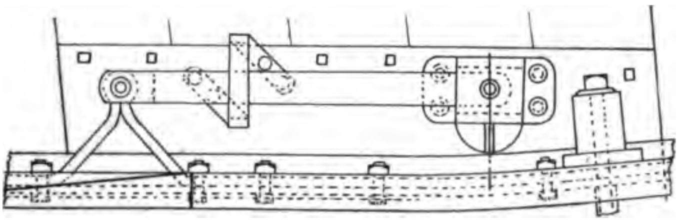


Fig. 5. Combination Anti-Creeper Hold-Down and Stop.

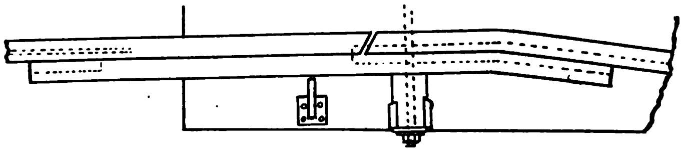


Fig. 6. Anti-Creeper Hinge Rail.

shown in Fig. 1, being riveted to spring rail. The spring is located about 11 ins. back of point and is of the design shown in the upper right-hand drawing in Fig. 2.

Four base plates have ends turned up, as shown in Fig. 14, to form stops for spring rail. Two holding-down devices, similar to design shown in Fig. 8 are used, with the exception that rivet is used instead of bolt at rail and bolts are square countersunk. The anti-creeper is of the design shown in Fig. 3 and is located in mouth of frog.

CHICAGO, ST. PAUL, MINNEAPOLIS & OMAHA RAILWAY.—The standard No. 9 spring rail frog is 15 ft. long and 8 ft. from heel to point. Seven base plates are used. The fixed wing rail is 10 ft. 6 ins. long and the spring wing rail is 12 ft. long. The spring rail is planed down to allow the passage of badly worn flanges.

The spring rail is reinforced with a bar fitting the section of rail and extending out about 1 in. from head of rail. The spring is located about 12 ins. back of point.

Four base plates have ends turned up, as shown in Fig. 14, to form stops for base of spring rail. Two holding-down devices are used, similar to design shown in Fig. 8, with the exception that the bar entering the device is riveted to the reinforcing bar. There is also a hold-down at the heel end of the spring rail and this

device is similar to design shown in Fig. 10. An anchor block is used in mouth of frog.

CINCINNATI, HAMILTON & DAYTON RAILWAY.—The standard No. 10 spring rail frog is 15 ft. long and 8 ft. 6 ins. from heel to point. The flangeway is 1¾ ins. Five plates are riveted to the frog. The spring wing rail and short point rail are planed down to permit easy passage of badly worn flanges.

The spring rail is reinforced with ¾-in. wrought iron bar, planed to fit between ball and flange of rail. The reinforcing bar is bent in a form similar to the one shown in Fig. 1. The cast iron spring case and follower with double spring is located 12 ins. ahead of point.

Two combined hold-downs and stops are used and three braces. Two braces are used with frogs from No. 6 to No. 9 inclusive. Three braces with frogs from No.

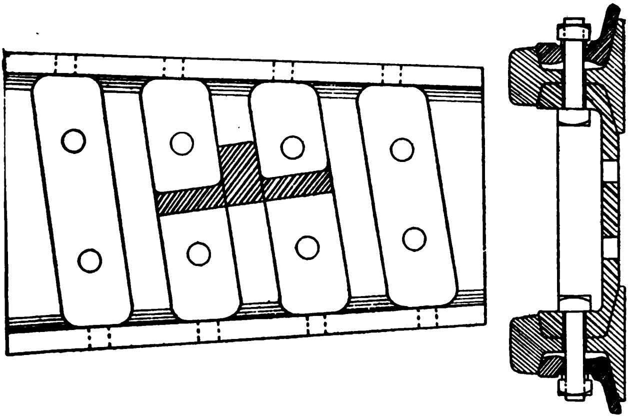


Fig. 7. Anti-Creeper Toe Block.

10 to No. 14 inclusive, and four braces with frogs Nos. 15 and 16. The anti-creeper is located in mouth of the frog and is of the design shown in Fig. 3.

DELAWARE & HUDSON COMPANY.—The standard No. 9 spring rail frog is 15 ft. long and 9 ft. from heel to theoretical point. The frog is riveted to large base plate about 4 ft. long and to 3 plates about 6 ins. wide. The spring rail is planed down to allow passage of badly worn flanges.

The spring rail is reinforced with a bar bolted to web of rail. One spring is located ahead of the point and is similar to design shown in Fig. 2. There is also a combined spring box and holding device, shown in Fig. 9, which is located back of the point. Besides the holding-down device mentioned above, there is a combined holding-down device and anti-rail creeper, which is located opposite point of frog, as in the design shown in

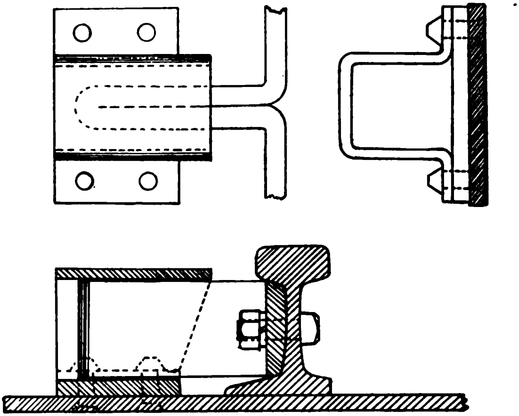


Fig. 8. Holding Down Device.

Fig. 5. Two rail braces are used as stops in connection with above devices.

DENVER & RIO GRANDE RAILROAD.—The standard No. 10 spring rail frog is 15 ft. long and 8 ft. 3 ins. from heel to point. The flangeway is 2 ins, wide. The frog is riveted to a plate 19 ins. wide and 7 ft. long.

The spring is of the design shown in the upper right hand drawing of Fig 2, and is located 15¾ ins. ahead of point. The spring rail is reinforced. A hinge rail is connected to the main rail by a bolt hinge and is connected to the movable part of the running rail by bolts. This design is shown in Fig. 6. It prevents creeping of the spring rail.

A stop of the design shown in Fig. 11 is used and also a stop is placed between the fixed and movable wing rails ahead of point. A hold-down device is also used back of point.

HARRIMAN LINES.—The standard No. 10 spring rail frog is 15 ft. long and 9 ft. 3 ins. from heel to theoretical point. Six base plates are used. The spring rail is

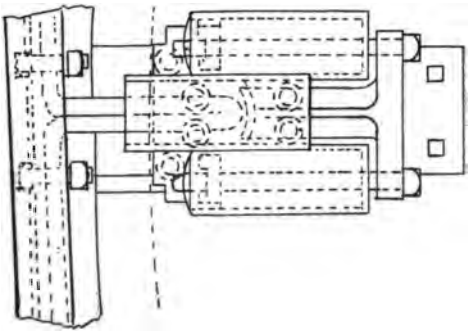


Fig. 9. Combination Holding Down and Spring Device.

planed down ⅜ in. to permit passage of badly worn flanges.

The reinforcing bar is of the design shown in Fig. 1, dimensions changed. The spring is of the design shown in upper right-hand drawing of Fig. 2 and is located 12 ins. back of point. A stop of the design shown in Fig. 12 is used. Two hold-down devices, shown in Fig. 8, are used. The anti-creeper is shown in Fig. 3, and is located in mouth of frog.

ILLINOIS CENTRAL RAILROAD.—The standard No. 10 spring rail frog is 14 ft. long and 7 ft. from heel to point. Tie-plates are used. The width of throat is 2 ins., tapers at back. Opening at actual point is 1¾ ins. The spring rail is planed down ½ in. to allow passage of badly worn flanges. The reinforcing bar is similar to the design shown in Fig. 1. The spring is located 12 ins. ahead of point. Stops similar to designs, shown in Figs. 12 and 14, are used. Two hold-down devices of design shown in Fig. 8 are used.

LEHIGH VALLEY RAILROAD.—The standard No. 10

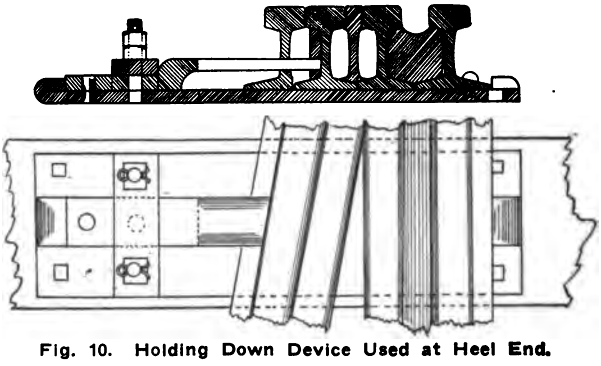


Fig. 10. Holding Down Device Used at Heel End.

spring frog is 15 ft. long and 9 ft. 6 ins. from heel to theoretical point. The flangeway is 1⅞ ins wide. Five base plates are used. The spring rail is planed down ½ in.

The reinforcing bar is of the design shown in Fig. 1. The spring is located 17 ins. ahead of point. One stop of design shown in Fig. 11 is used. Two hold-down devices of design shown in Fig. 8 are used. The anti-creeper of design shown in Fig. 3 is locaated in mouth of frog.

MICHIGAN CENTRAL RAILROAD.—The standard No. 11 spring frog is 16 ft. long and 8 ft. 9½ ins. from heel to point. The flangeway is 2 ins. wide. Six base plates are used. The spring rail is planed down to allow passage of badly worn flanges.

The spring rail is reinforced with a bar similar in design to the one shown in Fig. 1. The spring is located about 19 ins. ahead of point. Three base plates are bent up, as shown in Fig. 14, to form stops for spring rail. Two hold-down devices of the design shown in Fig. 8 are used. An anti-creeper of the design shown in Fig. 3 is located in mouth of frog.

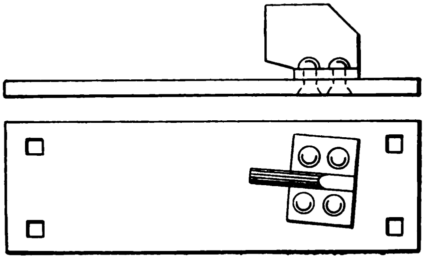


Fig. 11. Stop Riveted to Tie Plate.

NEW YORK, NEW HAVEN & HARTFORD RAILROAD.—The standard No. 10 spring rail frog is 16½ ft. long and 8 ft. 4 ins. from heel to theoretical point. The flangeway is 2 ins. wide. One base plate is riveted to frog, and seven tie-plates are used. The spring rail is planed down to allow passage of badly worn flanges.

The spring rail is reinforced with a bar which is bent out for connection with anti-creeper and hold-down device. The spring is located about 14 ins. ahead of point. Two rail braces are used as stops. A combined anti-creeper hold-down and stop device, shown in Fig. 5, is used. At the heel end of spring rail there is a hold-down device similar to design shown in Fig. 8.

PENNSYLVANIA LINES WEST OF PITTSBURGH.—The standard No. 10 spring frog is 15 ft. long and 8 ft. 6 ins. from heel to point. Five plates are used with frog. The spring and short point rails are planed down to allow passage of badly worn flanges.

The reinforcing bar is similar to design shown in Fig. 1 and is bolted to spring rail. A double coil spring,

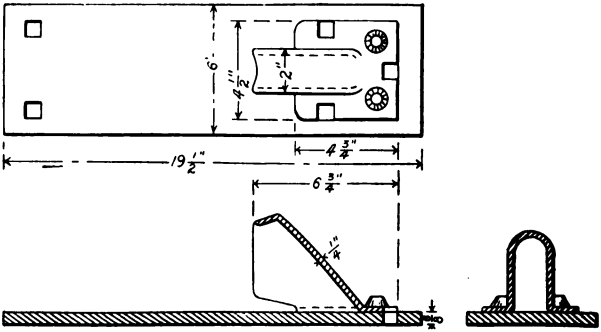


Fig. 12. Stop Riveted to Tie Plate.

similar to design shown in upper right-hand drawing of Fig. 2 is located ahead of point. Rail braces are riveted to the plates for stops for spring rail. Two holding-downs of design shown in Fig. 8 are used. An anti-creeper of design shown in Fig. 3 is located in mouth of frog.

PERE MARQUETTE RAILROAD.—The standard No. 10 spring frog is 15 ft. long and 8 ft. from heel to point. One base plate, ⅝x14x18x48 ins., and four tie-plates are used. The spring rail is planed down to allow passage of badly worn flanges.

The spring rail is reinforced. Spring is located ahead of point. Two tie-plates have ends turned up as shown in Fig. 14 to form stops for base plate. One stop is riveted to main base plate and consists of a bar, ¾x2x6 ins. A holding-down device is located at heel end of spring rail. An anti-creeper of design shown in Fig. 3 is located in mouth of frog.

PHILADELPHIA & READING RAILWAY.—The standard No. 10 filled and bolted spring rail frog is 15 ft. long and 9 ft. 3 ins. from heel to theoretical point. The width

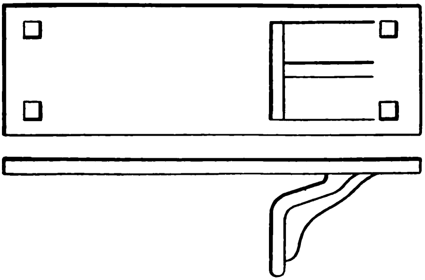


Fig. 13. Stop Rail Brace.

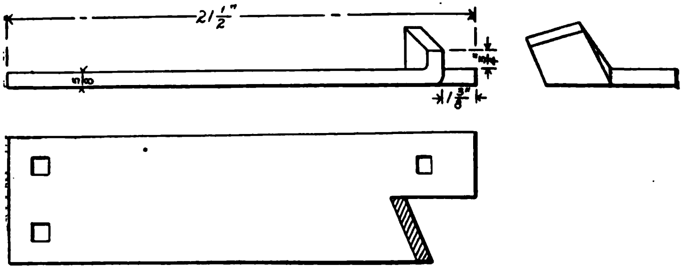


Fig. 14. Stop Tie Plate with end turned up.

of flangeway is 1¾ ins. and width of throat is 2 ins. Nine tie-plates are used. The spring rail is planed down.

The reinforcing strap for spring rail is ¾ ins. thick. The spring is located ahead of point. Four stops of a form similar to design shown in Fig. 13 are used. A holding-down device, shown in Fig. 10, is used toward heel end of spring rail. The anti-creeper located at toe of frog consists of a plain strap, shown in Fig. 4.

Elevation of Outer Rail in Inches.

Degree of Curve.	Velocity in Miles per Hour.													Degree of Curve.
	10	15	20	25	30	35	40	45	50	55	60	65	70	
1	0	⅛	¼	⅜	⅝	¾	1⅛	1⅜	1⅝	2	2⅜	2¾	3¼	1
2	⅛	⅜	½	⅞	1⅛	1⅝	2⅛	2⅝	3¼	4	4¾	5⅝	6½	2
3	¼	½	¾	1¼	1¾	2⅜	3⅛	4	4⅞	6	7⅛	8⅜	9¾	3
4	¼	⅝	1	1⅝	2⅜	3¼	4¼	5⅜	6⅝	8	9½	......	......	4
5	⅜	¾	1¼	2	3	4	5¼	6⅝	8¼	......	......	......	......	5
6	⅜	1	1⅝	2½	3⅝	4⅞	6¼	8	......	......	......	......	......	6
7	½	1⅛	1⅞	2⅞	4⅛	5⅝	7⅜	......	......	......	......	......	......	7
8	½	1¼	2⅛	3¼	4¾	6½	8⅜	......	......	......	......	......	......	8
9	⅝	1⅜	2⅜	3¾	5⅜	7¼	......	......	......	......	......	......	......	9
10	¾	1½	2⅝	4⅛	5⅞	8⅛	......	......	......	......	......	......	......	10
11	¾	1⅝	2⅞	4½	6⅝	8⅞	......	......	......	......	......	......	......	11
12	⅞	1⅞	3⅛	4⅞	7⅛	......	......	......	......	......	......	......	......	12
13	⅞	2	3⅜	5⅜	7¾	......	......	......	......	......	......	......	......	13
14	1	2⅛	3⅝	5¾	8⅜	......	......	......	......	......	......	......	......	14
15	1	2¼	3⅞	6¼	8⅞	......	......	......	......	......	......	......	......	15
16	1⅛	2⅜	4¼	6⅝	......	......	......	......	......	......	......	......	......	16
17	1¼	2⅝	4½	7	......	......	......	......	......	......	......	......	......	17
18	1¼	2¾	4¾	7½	......	......	......	......	......	......	......	......	......	18
19	1⅜	2⅞	5	7¾	......	......	......	......	......	......	......	......	......	19
20	1⅜	3	5¼	8⅛	......	......	......	......	......	......	......	......	......	20

CHAPTER VI.

Switches, Turnouts, Etc.

THE split switch in use on the majority of railroads is 15 feet in length for turnouts Nos. 7 to 12 inclusive, is less than 15 feet for turnouts Nos. 4, 5 and 6, and is greater for turnouts above No. 12. It has been recommended that 16½-foot switch points be used since rails of 33-foot length are supplied, but the 15-foot split switch is still the more common standard.

The elevation of switch rail above stock rail is usually made ¼ inch and it is effected by means of tie plates with pressed risers. The switch rail is about ⅝ inch below stock rail at point and reaches its greatest elevation above stock rail between 5 and 6 feet back of switch point. In most cases the switch rail falls to the elevation of stock rail at the heel of switch, the switch rail being bent and resting on risers of varying thickness. The switch rail may, however, retain the ¼-inch elevation to the heel of switch, the fall in elevation being in the lead rail beyond the heel of switch. In the latter case there is no vertical bend in the switch rail, which will, therefore, lie flat on the ties or riser plates, and the fall in elevation occurs in the lead rail which is fully spiked on both sides.

The elevation of switch rail above stock rail will be necessary as long as locomotive tires are allowed to become guttered. It is customary on many roads to limit the guttering to ¼-inch, chiefly because the wear on the

rails would be excessive if the track included more than one weight or design of rail, which often happens to be the case. Therefore to carry this "double flange" of $\frac{1}{4}$ inch over the stock rail, the switch rail is given a $\frac{1}{4}$-inch rise.

Tie rods of various designs are used. Some are adjustable and provide for insulation between rails. On 15-foot switch points two tie rods are sufficient.

In another column a detailed description of the split switches now in use is given. A table is also included and affords an easy means of comparison in regard to several important points.

CENTRAL RAILROAD OF NEW JERSEY.—The switch rail is planed down on top a total of 1 in. at point. Beginning 8 ins. back of the side planing, which is determined by angle of switch, the switch rail is planed down on top ¾ in. at the extreme point and then beginning 12 ins. back of point it is planed down an additional ¼ in. Beginning 12 ins. back of point the switch rail is chamfered to ⅛-in. thickness at extreme point and then the point is filed and rounded. The thickness at point after planing and before filing and chamfering is ¼ in.

The tie rods are made of ¾x2½-in. bars. Where insulation is necessary, the rods are made in two pieces and held by ½x2½x12-in. wrought iron splice plates, insulated with ⅛-in. fiber strap from tie rods, with ⅝-in. bolts in fiber bushings. Before and after assembling, a coat of insulating paint is applied to the insulated joint.

The tie plates are made of forged soft steel and are ½ in. thick with ⅜-in. risers. Back of the rail joints ½-in. tie plates are used under high rail to bring stock and point rails level at third tie back of joint; the ties being adzed to a true bearing before plates are applied.

Rail braces are made of cast iron. Reinforcing straps are 6 ft. 6 ins. in length for 15-ft. switch. Two stops of ⅝x1⅜-in. material are placed 10 ft. back from point of 15-ft. switch.

The 15-ft. split switch has two tie rods; the 20-ft. switch has three tie rods, and the 30-ft. switch has four tie rods. The switch rail is ⅝ in. below stock rail at point, is ⅜-in. below stock rail 12 ins. from point, is ⅜-in. above stock rail about 7 ft. from point and it re-

mains at elevation of 3/8-in. above stock rail to heel of switch, falling to level of stock rail at third tie from heel of switch.

CHICAGO & ALTON RAILWAY.—The standard 18-ft. split switch for 80-lb. rail has a 4¾-in. throw. The stock rail is bent 10½ ins. from point, giving a gauge at point of 4 ft. 8 9-16 ins.

The top of switch rail is 5/8 in. below stock rail at point, is 3-16 in. below stock rail 18 ins. from point, is 1/8 in. above stock rail at about 7 ft. from point, is 3-16 in. above stock rail at 11 ft. from point and then falls to level of stock rail at heel of switch.

The switch rails are reinforced with a 3/8x2 15-16-in. plate, 16 ft. long, which is riveted to the rail with ¾-in. rivets. The tie plates are made of ½-in. material with pressed risers for switch rails. Four tie rods are used and placed on 3-ft. centers.

The switch rail is planed on top a distance of 11 ft. from point. Beginning 11 ft. back of switch point it is planed down 1/8 in, for a distance of 3¾ ft., then 7-16 in. for the next 5¾ ft. and 7-16 in. for the remaining 1½ ft., making a total of 1 in. at extreme point.

CHICAGO & NORTHWESTERN RAILWAY.—The standard 15-ft. split switch for 90-lb. rail has a 5-in. throw. The stock rail is bent 1 ft. 1¼ ins. from point, giving a gauge of 4 ft. 8 5/8 ins. at point of switch.

The switch rail is 5/8 ins. below stock rail at point, is 7-16 ins. below stock rail 10 ins. from point, is 3/8 ins. above stock rail 5 ft. from point, remains at elevation of 3/8 ins. above stock rail for 2 ft. 3 ins. and then falls to level of stock rail in the next 5 ft. 3 ins.

The switch rail is planed down on top of head 1 in. in a distance of 5 ft. from point, it is planed on sides of head a distance of 6 ft. 10 7-16 ins. and on flange the entire length of rail.

Railroad—	Length of switch (feet)	Switch below stock rail at point (inches)	Throw of switch (inches)	Switch rail planed down (inches)	Width of switch rail at point	Elevation of switch above stock rail
C. R. R. of N. J.	15	5/8	4	1	1/8	..
C. & A.	18	5/8	4 3/4	1	1/8	1/8
C. & N. W.	15	5/8	5	1	1/4	3/8
C., B. & Q.	15	7/8	3 1/2	1 1/6	1/4	1/4
C., M. & St. P.	15	1/2	5	7/8	..	3/8
C., R. I. & P.	15	5/8	4 3/4	7/8	1/4	1/4
C., St. P., M. & O.	15	5/8	5	..	1/4	..
C., H. & D.	16 1/2	1/2	5	3/4	1/16	1/4
Cin. North.	16 1/2	..	5	..	3/16	..
D. & H.	15	5/16	3 7/8	5/8	3/8	5/16
D. & R. I.	15	1/2	4 5/8	7/8	9/16	..
G. N.	16 1/2	5/8	5	1 1/16	5/16	1/4
Har. Lins	15	5/8	4 3/4	1	1/8	..
Ill. Cent.	15	5/8	4 9/16	3/4	1/8	..
Inter-Col.	15	5/8	5	5/8	1/8	1/4
L. V.	15	3/8	4	5/8	1/16	1/4
M. Cent.	15	3/4	5	1 1/8	..	..
Mo. Pac.	13	1/2	4 1/2	1	..	1/4
N. Y., N. H. & H.	15	3/8	3 7/8	..	1/8	3/16
N. Y. C. & H. R.	15	5/8	4	5/8	1/8	1/4
P. L. W. of P.	18	1/2	4 1/2	3/4	1/16	1/4
Pere Marq.	15	5/8	5	3/4	..	1/8
P. & R.	15	5/8	4	1	1/8	3/8
Wabash	15	1/4	4 1/2	7/8	..	5/8

CHICAGO, BURLINGTON & QUINCY RAILROAD.—The 15-ft. switch for 85-lb. rail has a throw of 3 1/2 ins. The stock rail is bent 8 9-16 ins. from point on an angle of 1 deg. 40 mins. Two tie rods are used, the first having

two length adjustments and the second one adjustment.

The switch rail is 7/8 in. below stock rail at point, is level with stock rail 1 ft. 2 in. from point, rises to an elevation of 1/4 in. above stock rail 2 ft. 8 ins. from point, remains at elevation of 1/4 in. above stock rail for a distance of 3 ft. 3 ins. and then falls to level of stock rail at heel of switch.

CHICAGO, MILWAUKEE & ST. PAUL RAILWAY.—The 15-ft. standard split switch has a throw of 5 ins. The stock rail bend is 9 ins. from point of switch. Two tie rods are used, one of which is adjustable as to length.

The head of switch rail is planed down to a total of 7/8 ins. Beginning 3 ft. 10 ins. from switch point, it is planed straight to a point 1/2 in. below stock rail at point.

The switch rail is 1/2 in. below stock rail at point, is level with stock rail 26 ins. back of point, is 3/8 in. above stock rail 3 ft. 10 ins. back of point, is on an elevation of 3/8 in, for 3 ft. 3 ins. and falls gradually to level of stock rail at heel of switch.

CHICAGO, ROCK ISLAND & PACIFIC RAILWAY.—The 15-ft. split switch has a 4 3/4-in. throw at switch point. The bend in main stock rail begins 11 ins. from point, the gauge being 4 ft. 8 9/16 ins. at switch point.

The switch rail is 5/8 in. below stock rail at point, is level with stock rail 18 ins. from point, rises 1/4 in. above stock rail 6 ft. 6 ins. from point, is on an elevation of 1/4 in. above stock rail for a distance of 4 ft. 8 3/4 ins. and then falls to level of stock rail at heel of switch.

Two adjustable switch rods are used. Slide plates are 6 ins. wide and 5/8 ins. in thickness with pressed risers. Reinforcing bar for switch rail is 13 1/2 ft. long.

The 24-ft. switch has four adjustable tie rods. The top of switch rail is planed down 7/8 ins. The switch rail is 5/8 in. below stock rail at point, rises to same level 3 ft. 6 ins. from point, rises 1/4 in. above stock rail 10 ft. 6 ins. from point, remains 1/4 in. above stock rail for a distance of 9 ft. 3 3/4 ins. and then falls to same level at heel of switch. The stock rail bend begins 1 ft. 5 1/4 ins. from point, the gauge at point being 4 ft. 8 9/16 ins. Reinforcing bars for switch rails are 22 ft. in length. The switch angle is 1 deg. 02 mins. 40 secs.

CHICAGO, ST. PAUL, MINNEAPOLIS & OMAHA RAILWAY.—The 15-ft. standard split switch has a 5-in. throw. Two adjustable tie rods are used. Reinforcing plates for switch rails are 15 ft. in length.

The switch rail is planed down on top to a distance of 9 ft. and planed down 5/8 in. in the 18 ins. approaching point. Tie plates with pressed risers are used. Two gauge plates are used, one at point and other about midway between point and heel.

CINCINNATI, HAMILTON & DAYTON RAILWAY.—The 16 1/2-ft. switch for 85-lb. rail has a 5-in. throw. The stock rail is bent 10 1/2 ins. from point.

The switch rail is planed down 3/4 of an inch in the 5 ft. to point. At point switch rail is 1/2 in. lower than stock rail, it rises 1/4 in. above stock rail at distance of 5 ft. from point, it is level with stock rail for a distance of 6 ft. 6 ins. and it falls to level of stock rail in the next 3 ft. 6 ins.

Reinforcing plates are 3/8 in. in thickness and 13 ft. in length. Tie plates with pressed risers are used. Gauge plate is used at point and stops at distance of about 10 ft. from point.

CINCINNATI NORTHERN RAILROAD. The 15-ft. switch has a 5-in. throw. The stock rail is bent 9 ins. from point. Two tie rods are used.

The standard length switch now is 16½ ft. with tie rods.

DELAWARE & HUDSON COMPANY.—The 15-ft. switch rail is placed down ⅝ in. on top a distance of 5 ft. 3 ins. from point. The switch rail is 5/16 in. below stock rail at point, it rises to an elevation of 5/16 in. above stock rail in distance of 5 ft. 3 ins., is on elevation of 5/16 in. for a distance of 1 ft. and falls to level of stock rail in the next 5 ft.

Four tie rods are used and tie plates are used up to fourth tie rod, that is six plates on each rail. The gauge at point is 4 ft. 9 ins.

DENVER & RIO GRANDE RAILROAD.—The 15-ft. standard split switch has a 4⅝-in. throw. The stock rail is bent 6⅜ ins. from point on bend of 1 in 34. Four tie rods are used and placed on 3 ft. 4 in. centers.

The switch rail is planed down a total of ⅞ ins. and is ½ in. below stock rail at point. The width of switch rail is 9/16 in. at point.

GREAT NORTHERN RAILWAY.—The 16½-ft. split switch has a 5-in. throw. The stock rail is bent 12 ins. from point.

The switch rail is planed down 1 1/16 in. on top. It is ⅝ in. below stock rail at point, it rises to level of stock rail at distance of 2 ft. from point, it rises ¼ in. above stock rail in the next 5 ft. and then falls to level of stock rail at heel of switch.

Tie plates are ½ in. in thickness with pressed risers

from 1/16 to ⅜ in. Reinforcing plates for switch rail are 15 ft. and 13 ft. 8¼ ins. in length.

HARRIMAN LINES.—The 15-ft. split switch has a 4¾-in. throw. The stock rail is bent 11½ ins. from point, giving a gauge at point of 4 ft. 8 9/16 ins.

The switch rail is ⅝ ins. below stock rail at point, is level with stock rail 18 ins. from point, rises ¼ in. above stock rail 6 ft. 6 ins. from point and then falls gradually to level of stock rail.

Two adjustable insulated tie-rods are used. Reinforcing plate for switch rail is 13½ ft. long.

On the 24 ft. split switch, the switch rail is ⅝ in. below stock rail at point, is level with stock rail 3 ft. 6 ins. from point, rises ⅜ in. above stock rail 10 ft. 6 ins. from point, is at an elevation of ¾ in. above stock rail for a distance of 2 ft. 3¾ ins. and then falls gradually to level of stock rail. The bend in stock rail is 1 ft. 5½ ins. from point. Five insulated adjustable tie rods are used and placed 3 ft. 2 ins. on centers.

ILLINOIS CENTRAL RAILROAD.—The 15-ft. standard split switch has a 4 9/16 in. throw. The stock rail is bent 9 ins. from point, giving a gauge at switch point of 4 ft. 9 ins.

The switch rail is planed down ¾ ins. in 6 ft. It is about ⅝ in. below stock rail at switch point, rises about ¼ in. above stock rail at distance of 6 ft. from point and then falls to level of stock rail at heel of switch.

Two adjustable tie rods are used. Reinforcement plates for switch rail are 13 ft. 2 ins. long and 12 ft. 10 ins. long.

INTERCOLONIAL RAILWAY.—The 15-ft. standard split

switch has a 5-in. throw. The stock rail is bent 1 ft. 4⅜ ins. from point. Two tie rods are used.

The switch rail is ⅝ in. below stock rail at point and rises ¼ in. above stock rail 5 ft. from point.

LEHIGH VALLEY RAILROAD. The 15-ft. standard switch has a 4 in. throw. The stock rail is bent 12 ins. from point, giving a gauge of 4 ft. 8⅞ ins. at switch point.

The switch rail is planed down ⅞ in. on top for rails under 90 lbs., either ⅝ or ⅞ in. for 90-lb. rail, depending on type, and ⅝ in. for 100-lb. rail. With 90 A and 100 A rail the switch rail is ⅜ in. below stock rail at point, rises to ¼ in. above stock rail at distance of 5½ ft., is at elevation of ¼ in. above stock rail for 5½ ft. and then falls to level of stock rail at heel of switch.

Two tie rods are used, which have an insulated joint, if necessary. Reinforcing bars for switch rail are 9 ft. 5 ins. long.

With the 21-ft. standard switch the throw is 4 ins. and three tie rods are used. The switch rail rises ¼ in. above stock rail 6 ft. 6 ins. from point.

MICHIGAN CENTRAL RAILROAD.—The standard 15-ft. switch has a 5-in. throw. The stock rail is bent 8 ins. from point.

The switch rail is ¾ in. below stock rail at switch point. The total amount planed from top of rail is 1⅛ ins., beginning 10 ft. back of point. The switch and stock rails are on same level, 2 ft. back of point. Two adjustable tie rods are used.

MISSOURI PACIFIC RAILWAY. The standard 13-ft.

split switch has a 4½-in. throw. The stock rail is bent 8½ ins. from point.

The switch rail is ½ in. below stock rail at point, is level with stock rail 2 ft. 9 ins. from point, is ¼ in. above stock rail 4 ft. from point, remains at an elevation of ¼ in. above stock rail for 4 ft. and falls to level of stock rail at heel of switch. Two adjustable tie rods are used.

With the 11-ft. switch the throw is 4½ ins. and bend in stock rail is 7 ins. from point.

New York Central & Hudson River Railroad.—The 15-ft. switch has a 4-in. throw. The stock rail is bent 1 ft. 4¾ ins. from point.

The switch rail is ⅝ in. below stock rail at point, is ¼ in. above stock rail 5 ft. from point, remains at elevation of ¼ in. above stock rail for 5 ft., and then falls to level of stock rail.

Two adjustable tie rods are used. Reinforcing plates are ⅜ in. in thickness and extend the length of switch rail.

New York, New Haven & Hartford Railroad.—The 15-ft. standard split switch for 100-lb. rail has a 3⅞-in. throw. The stock rail is bent 11¾ ins. from point.

The switch rail is ⅜ in. below stock rail at point, it rises 3/16 in. above stock rail at distance of about 5 ft. 6⅞ ins. from point and then falls gradually to same level at a distance of about 3½ ft. from heel. Five tie rods are used and placed on 2-ft. centers. Spread at heel is 6¼ ins.

The 15-ft. switch for 80-lb. rail has spread of 5¾ in. at heel.

Pennsylvania Lines West of Pittsburgh.—The

18-ft. standard split switch has a 4½-in. throw. Two adjustable tie rods are used. Reinforcing plates are 16½ ft. in length.

The switch rail is ½ in. lower than stock rail at point, is level with stock rail about 2 ft. 9 ins. from point, is ¼ in. above stock rail 5 ft. 3 ins. from point, remains at an elevation of ¼ in. above stock rail for a distance of 5 ft. and then falls to level of stock rail in the next 5 ft. 3 ins.

With the 30-ft. switch, the switch rail is ½ in. below stock rail at point, is ¼ in. above stock rail 9 ft. from point, remains at ¼ in. above stock rail for 10 ft. and then falls to elevation of stock rail in next 8 ft. Five tie rods are used, two of which are adjustable.

PERE MARQUETTE RAILROAD. The 15-ft. standard split switch has a 5-in. throw. Two adjustable tie rods are used.

The switch rail is ⅝ in. above stock rail at point, is level with stock rail at distance of 18 ins. from point, is ⅛ in. above stock rail at distance of 8 ft. from point and then falls to level of stock rail at heel of switch.

PHILADELPHIA & READING RAILWAY.—The standard switches have a 4-in. throw. The construction is similar to that of the Central Railroad of New Jersey.

WABASH RAILROAD.—The standard 15-ft. split switch for 70-lb. rerolled rail has a 4½-in. throw. The stock rail is bent 8 ins. from point. The switch rail is ¼ in. below stock rail at point, is even with stock rail 8 ins. from point, is ⅝ ins. above stock rail 5 ft. 3 ins. from point and then falls to level of stock rail about 12 ft. from point of switch.

Baltimore & Ohio Railroad.—With turnouts Nos. 4 and 5, 11-ft. switches are used; with turnout No. 6 a 13-ft. switch; with turnout No. 7, a 15-ft. switch; with turnout Nos. 8 and 10, 16½-ft. switches; with turnout No. 16, a 24-ft. switch, and with turnout No. 20, a 30-ft. switch.

The No. 8 turnout with 16½-ft. switch and 15-ft. spring and rigid frog has a lead of 67 ft. The degree of turnout curve is 12° 18′ 08″. The distance from toe to point of frog is 6 ft. 6 ins. The heel clearance of switch is 6½ ins.

The No. 10 turnout with 16½-ft. switch and 15-ft. spring and rigid frog has a lead of 77 ft. The degree of turnout curve is 7° 12′ 12″.

The No. 16 turnout with 24-ft. switch and 20-ft. spring and rigid frog has a lead of 120 ft. The degree of turnout curve is 2° 39′ 26″. The distance from toe to point of frog is 8 ft.

The No. 20 turnout with 30-ft. switch and 27-ft. rigid frog has a lead of 149 ft. 6 ins. The degree of curve is 1° 41′ 17″. The distance from toe to point of frog is 9 ft. 6 ins.

With crossover No. 7 the distance from point to point of frogs is 24 ft. ½ in.; with No. 8, 27 ft. 7 ins.; with No. 10, 34 ft. 8 ins.; with No. 12, 41 ft. 8¾ ins.; with No. 16, 55 ft. 9½ ins., and with No. 20, 69 ft. 10 ins. The distance between track centers is 13 ft.

Central Railroad of New Jersey.—The No. 8 turnout with 20-ft. switch and 12-ft. frog has a lead of 72 ft. 10 3-16 ins. The angle of switch is 1° 27′ 45″, angle

of frogs 7° 09′ 10″, and the radius of center line of turnout curve is 482.69 ft. The distance from toe to point of frog is 4 ft. 10½ ins. Standard 15-ft. guard rails are used with all turnouts and crossovers.

The No. 10 turnout with 20-ft. switch and 15-ft. frog has a lead of 83 ft. 4 15-16 ins. The angle of frog is 5° 43′ 29″ and the radius of center line of turnout curve is 765.32 ft. The distance from toe to point of frog is 6 ft. 5⅝ ins.

*The No. 12 turnout with 20-ft. switch has a lead of 94 ft. 2½ ins. The angle of frog is 4° 46′ 19″ and radius of center line of turnout curve is 1,175,39 ft. The distance from toe to point of frog is 6 ft. 3¾ ins.

The No. 15 turnout with 30-ft. switch has a lead of 126 ft. 7⅜ ins. The angle of switch is 0° 54′ 55°, the angle of frog is 3° 49′ 06″, and the radius of center line of turnout curve is 1,754.45 ft. The distance from toe to point of frog is 8 ft. 8½ ins.

CHICAGO & ALTON RAILWAY.—The No. 10 turnout with 18-ft. switch and 15-ft. frog has a lead of 83 ft. The distance from toe to point of frog is 7 ft. Guard rails are 15 ft. long with 1⅞ ins. flangeway. With No. 10 crossover the distance between frog points is 34 ft. 9 ins. for 13-ft. track centers.

CHICAGO & NORTHWESTERN RAILWAY.—The No. 10 turnout with 15-ft. switch and 15-ft. frog has a lead of 81 ft. 6 ins. from switch point to theoretical frog point. The distance from toe of frog to theoretical point is 6 ft. 6 ins. The angle of frog is 5° 43′ 30″ and the degree of turnout curve is 6° 05′. The outside rail is bent to curve of 884.3-ft. radius. With the No. 10 crossover the dis-

tance between theoretical frog points is 36 ft. 1 15-16 ins.

CHICAGO, MILWAUKEE & ST. PAUL RAILWAY.—The No. 8½ turnout with 15-ft. switch and 10-ft. frog has a lead of 71 ft. The distance from toe to point of frog is 4 ft. The guard rails are 10 ft. long.

The No. 10 turnout with 15-ft. switch and 15-ft. spring frog or 11-ft. rigid frog has a lead of 79 ft. The distance from toe to point of spring frog is 8 ft. Spring frogs are used in main track and rigid frogs in other tracks.

The lead of No. 7 turnout is 64 ft.

CHICAGO, ROCK ISLAND & PACIFIC RAILWAY. — The No. 10 turnout with 15-ft. switch and 15-ft. frog has a lead of 77 ft. 8 ins. The degree of turnout curve is 7° 18′. The distance from toe to point of frog is 6 ft. 8 ins.

The No. 15 turnout with 24-ft. switch and 20-ft. frog has a lead of 121 ft. 4¼ ins. The degree of turnout curve is 3° 07′. The distance from toe to point of frog is 7 ft. 6 ins.

With crossover No. 10 the distance between frog points is 30 ft. 10½ ins. for 13-ft. track centers and with No. 15 crossover the distance is 60 ft. 4⅞ ins.

CHICAGO, ST. PAUL, MINNEAPOLIS & OMAHA RAILWAY.—The No. 8 turnout with 20-ft. switch is 58.8 ft. from heel of switch to point of frog. The No. 9 turnout with 20-ft. switch is 65 ft. from heel of switch to point of frog, and the No. 9 turnout with 16-ft. switch and 9-ft. frog is 63 ft. from heel of switch to point of frog, the distance between toe and point of frog being 3 ft.

GREAT NORTHERN RAILWAY.—The No. 9 turnout with

15-ft. switch and rigid frog has a lead of 78 ft. 6 ins. The distance from toe to point of frog is 7 ft.

The No. 9 turnout with 15-ft. switch and 15-ft. spring rail frog has a lead of 72 ft. The distance from toe to point of frog is 8 ft.

The No. 11 turnout with 16½-ft. switch and 16½-ft. spring rail frog has a lead of 85 ft. The switch angle is 1° 39′, the frog angle is 5° 12′, and the degree of turnout curve is 6° 04′. The distance from toe to point of frog is 7 ft. 6 ins. The clearance at heel of switch is 6 ins.

HARRIMAN LINES.—The No. 6 turnout with 10-ft. switch and 9-ft. frog has a lead of 48 ft. 10⅜ ins. The degree of turnout curve is 19° 59′. The distance from toe to point of frog is 3 ft. 6 ins.

The No. 6 turnout with 15-ft. switch and 9-ft. frog has a lead of 56 ft. 6 1-16 ins. The degree of turnout curve is 20° 46′.

The No. 7 turnout with 10-ft. switch and 10-ft. frog has a lead of 54 ft. 2 9-16 ins. The degree of turnout curve is 14° 06′. The distance from toe to point of frog is 3 ft. 9½ ins.

The No. 7 turnout with 15-ft. switch and 10-ft. frog has a lead of 62 ft. 7 11-16 ins. The degree of turnout curve is 14° 52′.

The No. 9 turnout with 15-ft. switch and 12-ft. frog has a lead of 73 ft. 9 5-16 ins. The degree of turnout curve is 8° 43′. The angle of frog is 6° 22′. The distance from toe to point of frog is 4 ft. 7½ ins. Guard rails for the above turnouts are 10 ft. long.

The No. 10 turnout with 15-ft. switch and 15-ft. frog

has a lead of 78 ft. 4 9-16 ins. The angle of frog is 5° 44′ and degree of turnout curve is 7° 10′. The distance from toe to point of frog is 6 ft. 2 ins. Guard rails are 15 ft. long.

The No. 12 turnout with 15-ft. switch and 16½-ft. frog has a lead of 87 ft. 7 9-16 ins. The angle of frog is 4° 46′ and degree of turnout curve is 4° 54′. The distance from toe to point of frog is 6 ft. 7 ins. Guard rails are 15 ft. long.

The No. 14 turnout with 24-ft. switch and 18-ft. frog has a lead of 115 ft. 2 11-16 ins. The angle of frog is 4° 06′ and degree of turnout curve is 3° 36′. The distance from toe to point of frog is 6 ft. 9 ins. Guard rails are 15 ft. long.

ILLINOIS CENTRAL RAILROAD.—The No. 7 turnout with 12-ft. switch and 11½-ft. frog has a lead of 57 ft. 4¾ ins. The distance from toe to point of frog is 4 ft. 6 ins. The degree of turnout curve is 15°. Guard rails are 15 ft. long. The clearance at heel of switch is 5½ ins.

The standard main track No. 10 turnout with 15-ft. switch and 14-ft. spring frog has a lead of 78 ft. ¼ in. The distance from toe to point of frog is 7 ft. The angle of switch is 1° 42′ 39″, the angle of frog 5° 43′ 55″, and the degree of turnout curve is 7° 22′ 32″, the radius being 777.37 ft. The clearance at heel of switch is 5½ ins. Guard rails are 15 ft. long. With No. 10 crossover the distance from point to point of frog is 34 ft. 7½ ins. for 13-ft. track centers, 44 ft. 7⅛ ins. for 14-ft. track centers and 54 ft. 6⅝ ins. for 15-ft. track centers.

INTERCOLONIAL RAILWAY.—The No. 8 turnout with 15-ft. switch and 12-ft. frog has a lead of 67 ft. 7 ins. The distance from toe to point of frog is 4 ft. 10 ins. The degree of turnout curve is 11° 32′, the radius being 497.4 ft. The clearance at heel of switch is 5½ ins.

The No. 9 turnout with 15-ft. switch and 12-ft. frog has a lead of 73 ft. 5 ins. The distance from toe to point of frog is 4 ft. 10½ ins. The degree of turnout curve is 8° 48′, the radius being 652.6 ft. The clearance at heel of switch is 5½ ins.

The No. 9 turnout with 15-ft. switch and 15-ft. spring frog has a lead of 72 ft. 2½ ins. The distance from toe to point of frog is 6 ft. 10½ ins. The degree of turnout curve is 9° 22′, the radius being 612.4 ft. The clearance at heel of switch is 5½ ins.

The No. 10 turnout with 15-ft. switch and 15-ft. spring frog has a lead of 77 ft. 8 ins. The distance from toe to point of frog is 7 ft. The degree of turnout curve is 7° 20′, the radius being 781.5 ft. The clearance at heel of switch is 5½ ins. The angle of switch is 1° 40′ and angle of frog is 5° 44′.

KANSAS CITY, MEXICO & ORIENT RAILWAY.—The No. 6 turnout with 15-ft. switch and 9¼-ft. frog has a lead of 56 ft. 3¾ ins. The angle of switch is 1° 40′, the angle of frog is 9° 32′ and the degree of turnout curve is 20° 4′. The distance from toe to point of frog is 3 ft. 6 ins. Clearance at heel of switch is 5½ ins. Guard rails are 10 ft. long.

The No. 7 turnout with 15-ft. switch and 10¼-ft. frog has a lead of 62 ft. 3 15-16 ins. The angle of frog is 8° 10′ and the degree of turnout curve is 15°. The distance from toe to point of frog is 3 ft. 10½ ins.

The No. 9 turnout with 15-ft. switch and 12-ft. 8⅜-in. frog has a lead of 73 ft. 2⅛ ins. The angle of frog is 6° 22′ and degree of turnout curve is 8° 43′. The distance from toe to point of frog is 5 ft. 5-16 in.

The No. 10 turnout with 15-ft. switch and 14-ft. frog has a lead of 78 ft. 4⅛ ins. The distance from toe to point of frog is 5 ft. 6 ins. Guard rails are 10 ft. long.

LEHIGH VALLEY RAILROAD.—The No. 12 turnout with 15-ft. switch has a lead of 84.03 ft. The distance from toe to point of frog is 7 ft. The clearance at heel of switch is 6 ins. The frog angle is 4° 46′ and degree of turnout curve is 5°, the radius being 1,146.01 ft. Guard rails are 15 ft. long. With the No. 12 crossover the distance from point to point of frogs is 44.07 ft. for 13-ft. track centers.

The No. 10 crossover with 15-ft. switch has a lead of 74.93 ft. The frog angle is 5° 44′, and the degree of turnout curve is 7° 33′, the radius being 759.16 ft. The distance from point to point of frogs is 37¼ ft.

MISSOURI, KANSAS & TEXAS RAILWAY.—The No. 7 turnout with 15-ft. switch and 15-ft. frog has a lead of 62 ft. 1½ ins. The distance from toe to point of frog is 7 ft. 1½ ins. The clearance at heel of switch is 5½ ins.

The No. 9 turnout with 15-ft. switch and 15-ft. spring frog has a lead of 71 ft. 11⅜ ins. Guard rails are 15 ft. long.

MISSOURI PACIFIC RAILWAY.—The No. 4 turnout with 11-ft. switch and 8-ft. frog has a lead of 40 ft. The distance from toe to point of frog is 3 ft. The degree of turnout curve is 49° 46′ 12″. The clearance at heel of switch is 5½ ins.

The No. 6 turnout with 13-ft. switch and 8-ft. frog has a lead of 54 ft. The distance from toe to point of frog is 3 ft. The degree of turnout curve is 19° 58′ 20″.

The No. 8 turnout with 13-ft. switch and 15-ft. frog has a lead of 63 ft. 6 ins. The distance from toe to point of frog is 6 ft. 6 ins. The degree of turnout curve is 11° 48′ 30″.

The No. 10 turnout with 15-ft. switch and 15-ft. frog has a lead of 74 ft. 6 ins. The degree of turnout curve is 6° 54′. The distance from toe to point of frog is 6 ft. 6 ins. The clearance at heel of switch is 6½ ins.

The No. 20 turnout with 30-ft. switch and 27-ft. frog has a lead of 149 ft. 6 ins. The distance from toe to point of frog is 9 ft. 6 ins. The clearance at heel of switch is 6½ ins. The degree of turnout curve is 1° 40′ 28″.

Pennsylvania Lines West of Pittsburg.—The No. 6 turnout with 18-ft. switch and 8-ft. frog has a lead of 54 ft. The radius of turnout curve is 244 ft. The distance from toe to point of frog is 3 ft.

The No. 7 turnout with 18-ft. switch and 15-ft. spring frog has a lead of 64½ ft. The distance from toe to point of frog is 6½ ft. The radius of turnout curve is 356.7 ft.

The No. 8 turnout with 18-ft. switch and 15-ft. frog has a lead of 74½ ft. The distance from toe to point of frog is 6½ ft. The radius of turnout curve is 528.5 ft.

The No. 10 turnout with 18-ft. switch and 15-ft. frog has a lead of 84½ ft. The distance from toe to point of frog is 6½ ft. The radius of turnout curve is 859.8 ft.

The No. 15 turnout with 18-ft. switch and 20-ft. frog

has a lead of 106 ft. The distance from toe to point of frog is 8 ft. The radius of turnout curve is 2,190 ft.

The No. 15 turnout curve with 30-ft. switch and 20-ft. frog has a lead of 125½ ft. The distance from toe to point of frog is 8 ft. The radius of turnout curve is 1,787.5 ft.

The No. 20 turnout with 30-ft. switch and 27-ft. frog has a lead of 149½ ft. The distance from toe to point of frog is 9½ ft. The radius of turnout curve is 3,438 ft.

With crossover No. 7, the distance between frog points for 13-ft. track centers is 24 ft.; with No. 8, 27 ft. 7 3-16 ins.; with No. 10, 34 ft. 8 3-16 ins.; with No. 15, 52 ft. 3½ ins.; and with No. 20, 69 ft. 7¾ ins.

St. Louis Southwestern Railway.—The No. 7 turnout with 12-ft. switch and 7-ft. rigid frog has a lead of 59 ft. 6¼ ins. The distance from toe to point of frog is 2 ft. 7½ ins.

The No. 7 turnout with 15-ft. switch and 15-ft spring frog has a lead of 62 ft. 1½ ins. The distance from toe to point of frog is 7 ft. 1½ ins.

The No. 9 turnout with 15-ft. switch and 9-ft. rigid frog has a lead of 74 ft. 4½ ins. The distance from toe to point of frog is 3 ft. 4½ ins.

The No. 9 turnout with 15-ft. switch and 15-ft. spring frog has a lead of 72 ft. 1½ ins. The distance from toe to point of frog is 7 ft. 1½ ins.

The No. 11 turnout with 15-ft. switch and 15-ft. spring frog has a lead of 82 ft. 1½ ins. The distance from toe to point of frog is 7 ft. 1½ ins.

The No. 12 turnout with 15-ft. switch and 15-ft. spring frog has a lead of 92 ft. 1½ ins. The distance from toe to point of frog is 7 ft. 1½ ins.

CHAPTER VII.

Tie Plates

THE many designs of tie plates, shown herewith evidence the difference of opinion which exists among engineers as to the form of plate that is most effective in securing the desired results. Besides the deviation in the form of plates, there is also a wide variation in the dimensions of plates for the same weight of rail. It may not be possible for engineers to agree upon the best design without extensive investigations, yet it should not be so difficult to arrive at more common conclusions in regard to the necessary dimensions.

The thickness of plates is shown to vary between ⅜ and ½ in.; the width to vary between 5 and 8 ins., and the length between 8 and 9 ins. These dimensions refer particularly to the tie plates for 85-lb. rail, including both flat and flanged plates. If the plate, 7 or 8 ins. in width, does not protect the tie better than the 6-in. plate and does not have any appreciable increase in life over the narrower plate, then the use of a 6-in. plate certainly represents economy. With regard to the length of plates the same proposition holds good, but concerning the thickness of plates the different designs will not allow of a recommendation for a standard thickness without limiting conditions.

Some plates are of the same thickness throughout, while others are heavier at the shoulder of the plate than at the ends. There are too many designs to refer to details, but as a general proposition it can be seen that

in many designs there is no need for a continuation of the same thickness throughout the length of the plate.

Referring to the punching of plates many arrangements of spike holes are used. Plates are punched with two, three, four and five holes. Some can be used as right and left plates, some for two or more weights of rail and some for intermediate and joint plates. Probably the most important arrangement is the one for two weights of rail where a change in rail is contemplated. To some engineers the two-hole plate made in rights and lefts is preferable for ordinary conditions, because with this plate there are no open spike holes and water is not as accessible to the bottom of plate, there is no opportunity for the track man to put in more than the necessary number of spikes and the distance between spike holes can be maintained at approximately 3 ins., which is not possible in a 6-in. plate with three spike holes for right and left plates.

The object of this arrangement is to afford a comparison of the various designs of tie plates and to indicate the present practice of certain railroads. It was deemed best to illustrate the several methods of punching tie plates, the transverse and longitudinal sections of plates and the character of the flange on the bottom of the plate where sections would not suffice.

In Figure 1, the methods of punching intermediate plates are given. Diagrams Nos. 1 and 2 indicate the punching of right and left hand plates with or without shoulders, while Nos. 3 and 3a show the punchings which permit of the use of a single plate for both sides of the track. Diagram No. 4 shows a plate for two

different widths of rail bases. Diagrams Nos. 5 and 6 show four-hole plates which may be used as either rights or lefts, the only difference being that the spike holes in No. 6 are slightly staggered. Diagram No. 7 is for use with two widths of rail bases or two weights of rail. Diagrams Nos. 8 and 9 are right and left plates for two widths of rail bases and are not shoulder plates. Diagrams Nos. 10 and 11 have special punchings, illustrating plates now in use.

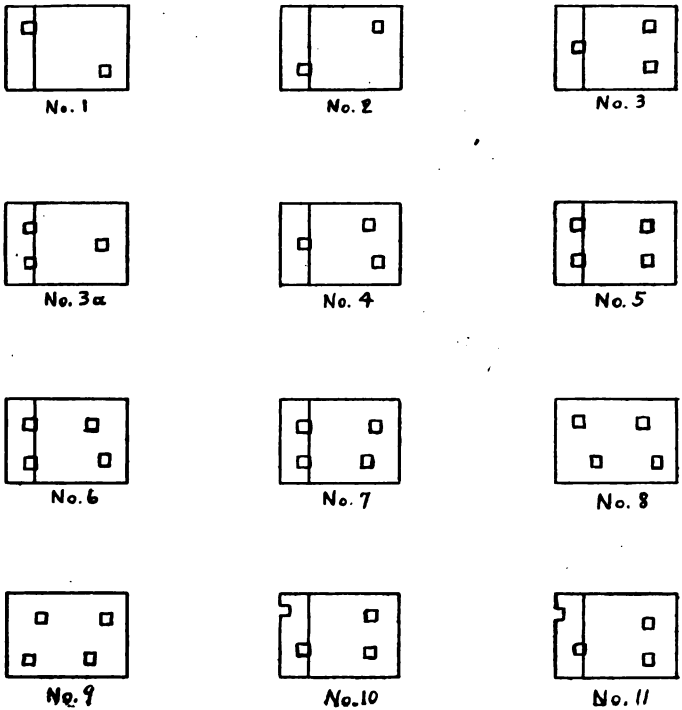


Fig. 1. Punching Diagrams for Intermediate Plates.

In Fig. 2 the methods of punching joint plates are shown. With the shoulder joint plate and spike hole inside of shoulder, the angle bar is usually slotted for the spikes and rests against the shoulder. With the low shoulder joint plate and spike hole at edge of plate, the base of rail may rest against the shoulder and the angle bar extend beyond the shoulder. Plates without shoulders are made both for angle bars with slotting and for angle bars without slotting, the distance between spike holes being increased over that for intermediate plates. Various methods of punching which embody the above principles are shown herewith. Joint plates are usually longer than intermediate plates and in some cases are wider.

In Figure 3, transverse sections of plates, taken parallel to the rails, are shown. The flat plate without shoulder, the flat plate with shoulder and flanged plates with or without shoulders are indicated. Flanges of several depths and arranged in various ways are given. Corrugated upper surfaces are indicated with the exceptions of certain plates upon which the corrugations rise above the main body of the plate.

In Figure 4, longitudinal sections of plates, taken in the direction of the tie, are given: Flanges are shown which are placed across the tie and against the grain of the wood. One section shows a plate reinforced beneath the shoulder. Plates are also grooved near the center where it is not necessary to have the full thickness of metal to maintain strength. Other plates decrease in thickness from the shoulder to the inner end of plate and thus cant the rail.

In Figure 5, certain arrangements of flanges and cor-

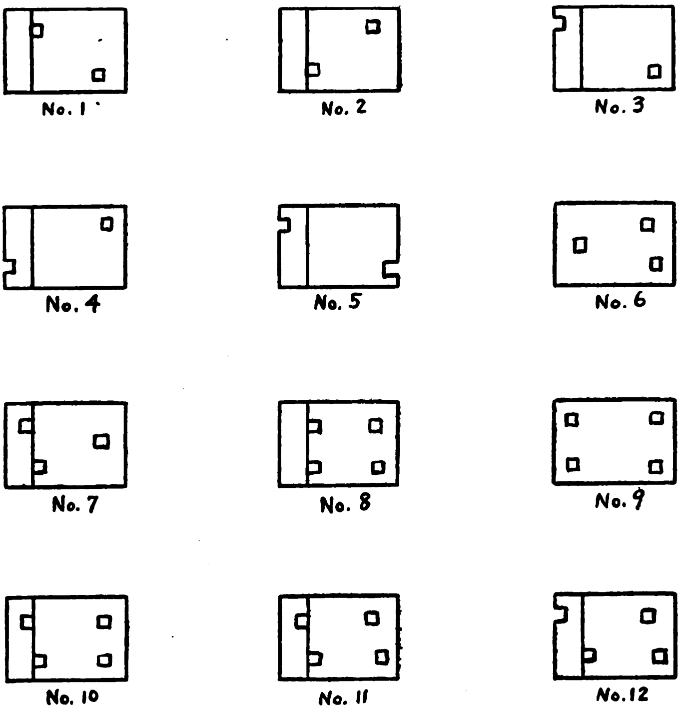


Fig. 2. Punching Diagrams for Joint Plates.

rugations are shown. Diagonal flanges or corrugations, as they are best termed on account of their small depth and arrangement, are shown on one plate, the corrugations being about ⅛-inch in depth. No. 2 shows more clearly the arrangement of flanges shown in No. 10, Figure 3, and No. 3, Figure 4.

In the following paragraphs, descriptions of standard tie plates are given, concluding with a table of dimensions.

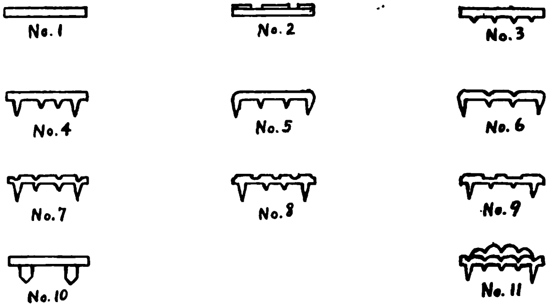


Fig. 3. Transverse Sections of Plates.

CENTRAL RAILROAD OF NEW JERSEY.—The standard tie plates are 6x9x½-ins. with 5-16-in. shoulders. The punching diagram is shown by diagram No. 11, Figure 1. The sections are similar to diagram No. 2, Figure 3, and Diagram No. 8, Figure 4. The joint plates are 8x11x½-ins. and the punching diagram for these plates is shown by Diagram No. 12, Figure 2. The plates are made of wrought iron or low carbon rolled steel.

CHICAGO & NORTHWESTERN RAILWAY.—The standard tie plates for 80- and 90-lb. rail are 5x8½x⅜-ins. The transverse section of plate is shown by Diagram No. 7, Figure 3. The punching diagrams are similar to Diagrams No. 8 and 9, Figure 1. The distance between centers of spike holes is 2⅞-ins.

CHICAGO, BURLINGTON & QUINCY RAILROAD.—The standard tie plates are 6x8½x½ ins., with 5-16 in. shoulders. The punching diagrams for intermediate plates are similar to diagrams Nos. 1, 2 and 4, Fig. 1. The distance between spike holes is 2 ins. The bottom surface has ⅛-in. corrugations as shown in diagram No. 1. Fig. 5.

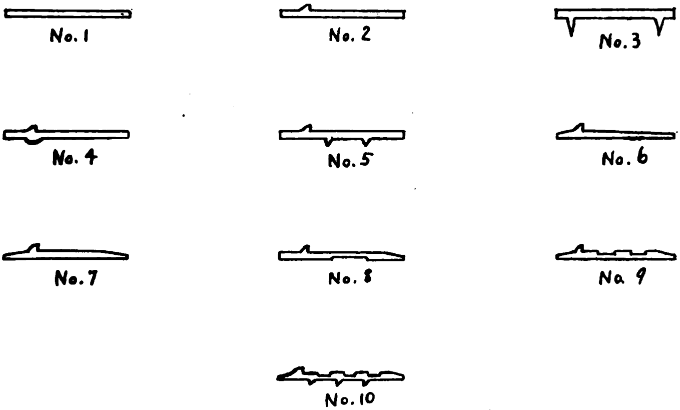


Fig. 4. Longitudinal Sections of Plates.

The longitudinal sections of the plates are similar to diagram No. 6 with the exception of the corrugations on the bottom surface.

CHICAGO, MILWAUKEE & ST. PAUL RAILWAY.—The standard tie plates for 85-lb. rail 5x8x9-32 ins. The shoulder is ¼ in. high and is placed only between the spike holes. The distance between centers of spike holes is 3½ ins. The punching diagram for intermediate plates is similar to diagram No. 5, Figure 1, and for joint plates is similar to No. 9, Figure 2. The joint plates do not have a shoulder and the distance between spike holes is increased to conform to slotting of splice bars. The flanges are ¼ in. wide and ¾ in. deep, being located as shown in diagram No. 3, Figure 5. Diagram No. 2, Figure 4, shows a longitudinal section of plate without flanges. The plates are made of malleable iron.

DENVER & RIO GRANDE RAILROAD.—The standard tie plates for 85-lb. rail are 6x8x5-16 ins. with ½ in. shoulders and 7x8½x⅜ ins. with 5-16 shoulders. The punching diagrams are similar to diagrams Nos. 3 and 5, Figure 1. The distance between centers of spike holes for the 4-hole plate is 4⅜ ins. and for the 3-hole plate 3¾ ins. The first design of plate has a section, shown by diagram No. 11, Figure 3, and the second design has a section similar to diagram No. 7, Figure 4, with the exception of transverse corrugations on the top of plate. The punching diagram for joint plates is shown by diagram No. 8, Figure 2. The joint plates are about 1 in. longer than the intermediate plates.

GRAND RAPIDS & INDIANA RAILWAY.—The standard tie plates for 85-lb. rail are 5x7½x⅜ ins. The punching diagrams are similar to No. 5, Figure 1. The transverse section of plate is similar to No. 2, Figure 3, but it has a flange on bottom surface which is ¼-in. wide and ⅞ in. deep extending the full length of plate.

GREAT NORTHERN RAILWAY.—The tie plates are made 6x8 ins., but vary in thickness from 5-16 to ½ in. The height of shoulder varies between ¼ and ⅜ ins. The punching diagrams are similar to diagrams Nos. 2, 3 and 5, Figure 1. The distance between centers of spike

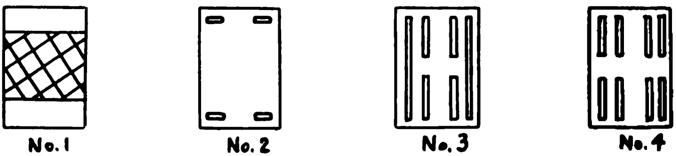


Fig. 5. Bottom Views of Plates.

holes is 3 ins. One design of plate has a section similar to diagram No. 8, Figure 3, with short flanges 3/8 in. deep and long flanges 15-16 ins. deep; a second design of plate has flanges 7-16x2 ins., 5/8 in. deep, similar to diagram No. 4, Figure 5; a third design has a section similar to diagram No. 2, Figure 4, and a fourth design has flanges 5-16x1 in., 1¼ ins. deep, similar to diagram No. 2, Figure 5. Plates of rolled steel and malleable iron are used.

HARRIMAN LINES.—The standard tie plates for 90-lb. rail are 8x8¾x7-16 ins. The shoulder is ¼ in. high. The punching diagram is similar to diagram No. 5, Figure 1, but holes are staggered. Sections of the plate are given by diagram No. 1, Figure 3, and diagram No. 9, Figure 4. The distance between centers of spike holes is 3 ins.

Note.—Plates described in this particular note are the only ones applicable to Harriman Lines. Plates for other weights of rail are of same general dimensions.

Note.—Figures showing weights of rail with which tie plates are to be used are rolled in plate.

INTERCOLONIAL RAILWAY.—The intermediate steel tie plates for 80-lb. rail are 5x8x7-16 ins. tapered to 3/8 in. The distance between centers of spike holes is 2¼ ins. The punching diagrams are similar to diagrams Nos. 1 and 2, Figure 1. The longitudinal section of the plate is shown by diagram No. 10, Figure 4.

ILLINOIS CENTRAL RAILROAD.—The standard tie plates for 85-lb. rail are 5½x8x7-16 ins. with ¼ in. shoulders. The distance between spike holes is 5¼ ins. for 85-lb. rail. The punching diagram for intermediate plates is

Tie Plate Dimensions

Railroad—	Weight of Rail	Thickness of Plate	Width of Plate	Length of Plate	Height of Shoulder
C. R. of N. J....	90	1/2	6	9	5/16
C. & N-W......	90	3/8	5	8½	....
C., B. & Q.....	85	1/2	6	8½	5/16
C., M. & St. P.	85	5/16	6	8	1/4
D. & R. G.....	85	3/8	7	8½	5/16
G. R. & I......	85	3/8	5	7½	1/4
G. N...........	90	1/2	6	8½	5/16
Har. Lines.....	90	7/16	8	8¾	1/4
Ill. Cent........	85	7/16	5½	8	1/4
Inter-Col.	80	7/16	5	8	....
L. V...........	90	3/8	5	8	5/16
Mich. Cent.....	100	3/8	5	9	1/2
Mo. Pac.......	85	1/2	6½	8¾	1/4
P. L. W. of P..	85	1/2	7	8¼	3/8
P. L. W. of P..	100	5/8	7	9	3/8
Phila. & Read..	90	1/2	6	9	5/16

similar to diagram No. 3, Figure 1. The longitudina section is similar to diagram No. 7, Figure 4. Th punching diagram for joint plates is similar to diagran No. 6, Figure 2, the length of the plates being 9 ins.

Lehigh Valley Railroad.—The standard tie plate for 90-lb. rail are 5x8x⅜ ins. and 5x8½x5-16 ins. Th first design of plate has four flanges as indicated b diagram No. 2, Figure 5, and the second design has transverse section similar to diagram No. 8, Figure

The intermediate and joint plates are punched similar to diagrams Nos. 1 and 2, Figure 1. The first design is a shoulder plate and the distance between centers of spike holes is 2 ins. for intermediate and 4 ins. for joint plates, the width of joint plate being 6⅜ ins. In the second design the distance between centers of spike holes is 2¾ ins. for intermediate plates and 4 ins. for joint plates, the width of joint plate being 6 ins.

Pennsylvania Lines West of Pittsburg.—The standard tie plates of 85-lb. rail are 7x8¼x½ ins. and for 100-lb. rail are 7x9x⅝ ins. The shoulder on these plates is ⅜ in. high. The plates are punched similar to diagram No. 10, Figure 1, and have four ⅜x1 in. flanges, 1¼ in. deep as indicated by diagram No. 10, Figure 3; diagram No. 3, Figure 4, and diagram No. 2, Figure 5. Diagram No. 7, Figure 4, shows a longitudinal section of plate without flanges. The distance between centers of spike holes is 3¼ ins.

Philadelphia & Reading Railway.—The standard tie plates are of the same design as those for the Central Railroad of New Jersey.

Michigan Central Railroad.—The standard tie plates for 100-lb. rail are 5x9x⅜ ins., and for 60 to 80-lb. rail are 5x8x⅜ ins. The shoulder is ½ in. high. There are four flanges, as indicated by diagram No. 4, Figure 3, the inner flanges being ½ in. deep and the outer flanges being ¾ in. deep. The punching diagram for tie plates for 100-lb. rail is similar to diagram No. 3, Figure 1. The tie plates for 60, 65 and 80-lb. rail are punched with four spike holes.

Missouri Pacific Railway.—The standard tie plates

for 75 and 85-lb. rails are made 6½x8¾x½ ins. and 6x8x½ ins., with ¼-in. shoulders. The punching diagrams are similar to diagram No. 7, Figure 1. The bottom surface of the smaller plate is corrugated as shown by diagram No. 1, Figure 5, and the transverse and longitudinal sections of the plates are similar to diagrams No. 2, Figure 3, and No. 7, Figure 4, with the exception of the ⅛-in. corrugations on the bottom surface. The larger plate has ⅛-in. flanges similar to diagram No. 3, Figure 3.

CHAPTER VIII.

Fences, Cattle Guards, Etc.

THE following information is given in the Manual of Recommended Practice of the American Railway Engineering and Maintenance of Way Association:

FENCES—DEFINITION.

Anchor.—A device to prevent a fence or post from being raised or moved.

Anchor Post.—A fence post fixed or fastened in position.

Bottom Wire.—The lowest longitudinal wire of a fence.

Brace.—A piece of timber or metal, in compression, placed diagonally between adjacent posts.

Brace Panel.—A panel in which a brace, or tie, or both, are introduced.

Cleat.—A piece of wood or metal fastened transversely to the side of a post below the ground line to give it greater stability.

End Post.—A post at the end of a line or section of fence.

Fence.—Any barrier that serves to guard against unrestricted ingress and egress, especially a structure of posts, rails, wires, boards or pickets.

Fence Post.—An upright piece of timber, metal or other material used as a support for the attachment of the longitudinal members of the fence.

Fence Staple.—A metal device, in the shape of the letter "U" with ends sharpened, for fastening the longitudinal wires of the fence to the post.

Gate.—A movable barrier consisting of a frame or structure of wood, metal or other material for closing a passage or opening in a fence.

Gate Brace.—A piece of wood or metal serving the purpose of stiffening the frame of a gate.

Gate Frame.—The sustaining parts of a gate, fitted and framed together, to which the other members are attached.

Gate Hinge.—A device for attaching a gate to a post and upon which the gate swings.

Gate Latch.—A device for fastening the free end of a gate to a gate post.

Gate Post.—A post to which a gate is hung or latched.

Intermediate Post.—A post placed between end posts.

Intermediate Wire.—A longitudinal wire located between top and bottom wires.

Panel.—A section of fence between adjacent posts.

Snow Fence.—A structure erected for the purpose of accumulating drifting snow.

Stay.—A piece of timber, metal or other material, either vertical or inclined, serving the purpose of keeping the longitudinal wires the proper distance apart and stiffening the fence.

Stay Wire.—A stay formed of wire.

Tie Wire.—A wire in tension between any two posts.

Top Wire.—The highest longitudinal wire of a fence.

SURFACE CATTLE GUARDS—DEFINITIONS.

Apron.—The flaring panel of a fence set parallel with the track between the cattle-guard and the wing-fence.

Cattle-Guard.—A barrier placed at the intersection of a wing-fence with a railroad track to prevent the passage of livestock along the track.

Filler.—A piece of timber, metal or other material placed between the slats composing a section of a surface cattle-guard to space and stiffen them.

Section.—A group of slats or strips which go to make up a surface cattle-guard.

Slat.—Strip of wood or metal used to make up sections of a cattle-guard.

Wing-Fence.—The line of fence making connection between the apron of the cattle-guard and the right-of-way or line fence.

FENCES.

(1) The use of smooth wire in preference to barbed wire for railroad fences is recommended.

(2) The use of a heavy, smooth wire, or a plank at top of barbed wire fence, is recommended.

CATTLE-GUARDS.

The use of the surface cattle-guard in preference to the pit guard is recommended.

GENERAL REQUIREMENTS FOR SURFACE CATTLE-GUARDS.

The cattle-guard should be so constructed as to avoid projecting surfaces liable to be caught by dragging brake or other rigging.

It should be of such construction so as not to endanger employes who pass over it in the discharge of their duties.

It should be effective against all livestock, but have no

parts that would catch and hold animals endeavoring to cross.

It should be reasonable in first cost, durable and easily applied and removed, so as to permit repairs of track at minimum expense.

It should not rattle during the passage of trains.

SPECIFICATIONS FOR STANDARD RIGHT-OF-WAY FENCES BUILT WITH WOODEN POSTS.

1. Three classes of smooth wire fences may be used, the top wire classes of each to be 4 ft. 6 in. above the ground.

2. A first-class fence shall consist of nine longitudinal, smooth coiled, galvanized steel wires. The top and bottom wires shall be No. 7 gage; intermediate and stay wires shall be No. 9 gage.

The spacing of the longitudinal wires shall be, commencing at the bottom, 3, 4, 5, 6, 7, 8, 9 and 9 in. The bottom wire shall be 3 in. above the ground, and the stay wires shall be spaced 12 in. apart.

3. A second-class fence shall consist of seven longitudinal, smooth, coiled, galvanized steel wires; the longitudinal wires and stay wires shall be No. 9 gage.

The spacing of the longitudinal wires shall be, commencing at the bottom, 5, 6½, 7½, 9, 10 and 10 in. The bottom wire shall be 6 in. above the ground, and the stay wires shall be spaced 22 in. apart.

4. A third-class fence shall consist of four longitudinal, smooth, coiled, galvanized steel wire; the longitudinal and stay wires shall be No. 9 gage.

The longitudinal wires shall be spaced 14 in. apart;

the bottom wires shall be 12 in. above the ground, and the stay wires shall be spaced 22 in. apart.

GALVANIZED WIRE FENCING.

The rapid deterioration of modern woven galvanized fence wire is caused by the coating of the zinc being too thin and of an uneven thickness. To procure better protection to the wire and a longer-lived fence, it is necessary to secure an increased uniform thickness of the zinc coating on the wire; and to insure that the galvanizing is intact after the wire has gone through the fence-weaving machines, it is recommended that a second coat of zinc be applied to the fence after it is manufactured.

GATES FOR RIGHT-OF-WAY FENCES.

A hinged metal gate is recommended.

The width of farm gates should not be less than 12 ft., depending upon the size of agricultural machinery in use in the vicinity, or as required by the laws of the State through which the railroad operates. The minimum height of farm gates should be 4 ft. 6 in. from the surface of the roadway.

Farm gates should be hung so as to open away from the track, and if hinged, swing shut by gravity.

CHAPTER IX.

Tools and Supplies

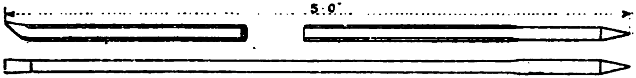
THE instructions relative to tools on the Canadian Pacific Railway are as follows:

"Each section must have a full equipment of good standard tools sufficient to supply every man in the gang, and several extra tools for the purpose of replacing any that may be sent to the shop for sharpening and repair.

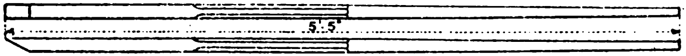
"The kind of tools will vary according to the ballast and other conditions. The following list will be the minimum required on all sections, and foremen and roadmasters must see that each section is fully equipped, and that they are in proper repair:

TOOL EQUIPMENT FOR SECTION GANG OF FOREMAN AND THREE MEN.

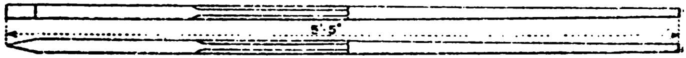
Adzes	2
Axes	1
Bars, Claw	2
" Crow	2
" Lining	2
" Tamping	2
Boards, Elevation	1
Brooms	1
Cars, Hand	1
" Push	1



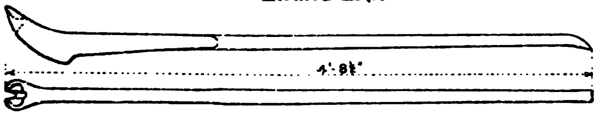
PINCH BAR.



CROW BAR



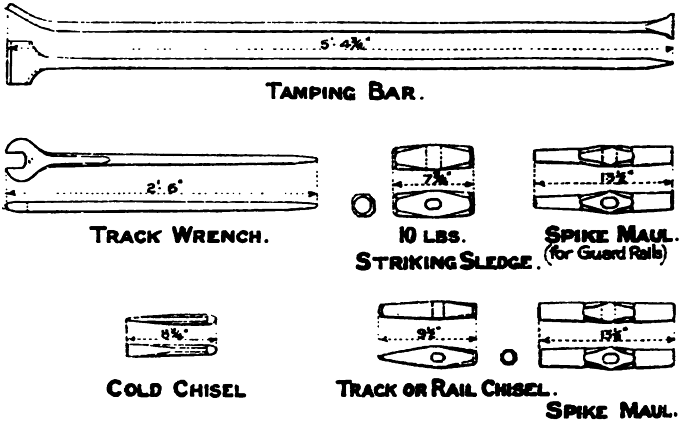
LINING BAR



CLAW BAR

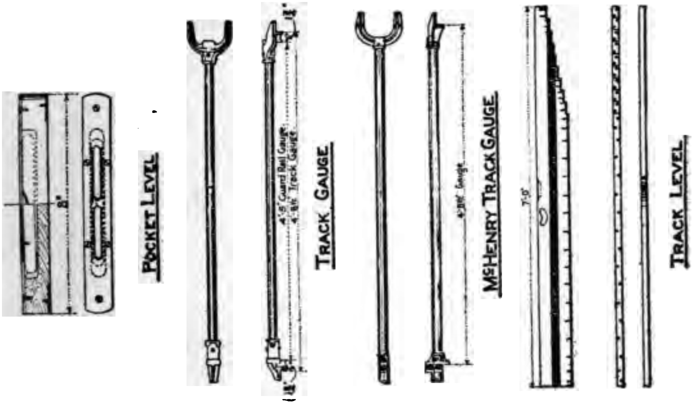
C. P. R. Track Tools.

Chisel, Rail	5
Cup, Tin	1
Flags, Red	2
" Yellow	2
Grindstone	1
Globes, Red	2
Gauge, Track	1
" White	2
" Yellow	2
Hammers, Maul	2
" Nail	1
" Sledge	1
Handles, Adze	1
" Axe	1
" Maul	2



C. P. R. Track Tools.

Handles, Pick	2
Jack, Track	1
Lanterns (complete)	4
Levels, Spirit, Pocket..............................	1
" Track..............................	1
Oil Can	1
Oiler	1
Oil (Signal), pints..............................	4
Padlock and Key and Chain..............................	2
Pail, Water	1
Picks and Handles..............................	4
Platform, Dumping, for Push Cars..............................	1
Ratchet and 3 Drills..............................	1
Saws, Hand	1
" Cross Cut..............................	1
Scythe (complete), Grass or Brush..............................	2



C. P. R. Track Gages and Levels.

Shovels, Track	6
Switch Key	1
Tape, 50 ft.	1
Template, Standard Roadbed	1
Torpedoes	12
Wrenches, Monkey	1
" Track	3

"Rail benders, fence tools, track drills, expansion shims, track thermometers, wheelbarrows and tools used by extra gang will be furnished to each roadmaster, to be sent out as required and returned to roadmaster's headquarters when work is completed. Tools in need of repair must be shipped by the foreman to the company's repair shops. Place a tag on each article, showing to whom it is to be returned, and send a requisition for repairs."

A Series of Interesting

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Railway Supplies

covers the

Remaining Pages

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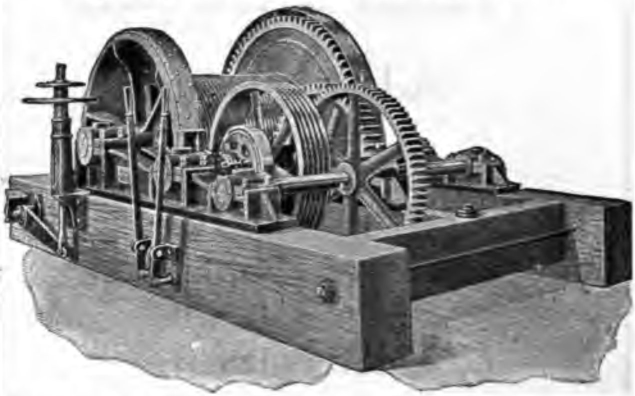
With Automatic Band Brake

Capacity 75 tons up a 20% incline



Coal Chutes Erected Complete. Coal Chute Machinery. Coal Chute Side Swaying Aprons. Locomotive Water Cranes. Water Tanks. Water Stations Complete. Water Treating Plants Complete. Bridge Turning Machinery. And many others ARE OUR SPECIALTIES.

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THE OTTO GAS ENGINE WORKS

CHICAGO, ILL.

HERCULES
Bumping Posts

The Hercules bumping posts are made entirely of metal, the legs being 7/16-in. boiler plate and the castings the best malleable iron; the anchorage consists of three one and one-quarter inch rods which, with the rear brace and the bolting of the legs to the rails, give these posts their great holding power; when crushed stone is used as ballast in the pit and around the ties under the post, as the manufacturers recommend, these posts will stand a shock of over one and one-half million foot pounds without damage to either cars or posts.

The No. 1 Hercules freight post is the only spring bumping post on the market and is equipped with six large coils back of the striking plate, which has a horn on its face to close the coupler.

The No. 2 Hercules freight post is of the same general construction throughout, but has no springs back of the striking plate.

The Hercules passenger post, either for regular service or for elevated tracks, is like the No. 1, but has the cylinder, which contains the coil springs, raised so that the striking plate will engage the buffer instead of the coupler.

The Little Giant posts are made from malleable iron and have four large coils, two in each leg, back of the striking plates which, in this post, engage the wheels. This post is intended for use on short stub or industrial tracks where a few loaded cars are to be set out. This line of bumpers is made by

The Railway and Traction Supply Co.

Rector Bldg. **CHICAGO**

Water Softeners in Railroad Service

To meet railroad requirements a water softener must be so simple in construction and operation that any novice can run it. It must be operated from the ground level—deliver the treated water to storage tank without repumping—furnish its own power—require but little care and cost little for maintenance.

The Booth Water Softener meets these requirements as no other softener ever did.

The great success of the Booth Water Softener is due to its matchless simplicity—its freedom from trouble—its general adaptability to railroad service and the fact that it can be relied upon at all times to produce the right results at the right cost.

We want you to examine this machine. Take an expert with you if you can. He will tell you that the "Booth" embodies the most successful principles of water softener construction—that in design—simplicity—convenience and economy of operation it represents the highest standard of engineering practice.

This machine, which has been selected in preference to all others,—by men who know water softener history—is the water softener you will prefer when you know it.

Write today for our booklet "Hard Water Made Soft." It tells you in detail about the Booth Water Softener.

L. M. BOOTH CO.

CHICAGO, Fisher Building.

NEW YORK, 136 Liberty Street.

Booth Water Softener

VANDALIA RAILROAD
Terre Haute, Ind.

L. M. BOOTH CO.

CHICAGO, Fisher Building
NEW YORK: 186 Liberty St.

The Softener that has Proved Every Claim

Every feature of the Booth Water Softener has been tested and proven—Not a single part is radical or experimental—It embodies the most successful principles of water softener design.

Simplicity is the very keynote of the Booth—All the usual complications have been eliminated—There are no freakish ideas to confuse the operator.

In the Booth Water Softener the value is all there before your eyes in good, sound, softener sense, design and material.

All parts are interchangeable — That means — that should any part become broken, any similar part in our entire output could immediately take its place—Sometimes that means a great deal to the owner.

Our claims of greater value—greater efficiency—and greater economy—are based upon actual results obtained. The proving of these claims alone have sold more Booth Water Softeners than all other efforts we have put forth.

The Booth is almost trouble proof.—Put in the chemicals once in twelve hours—the water entering the softener for treatment does the rest.

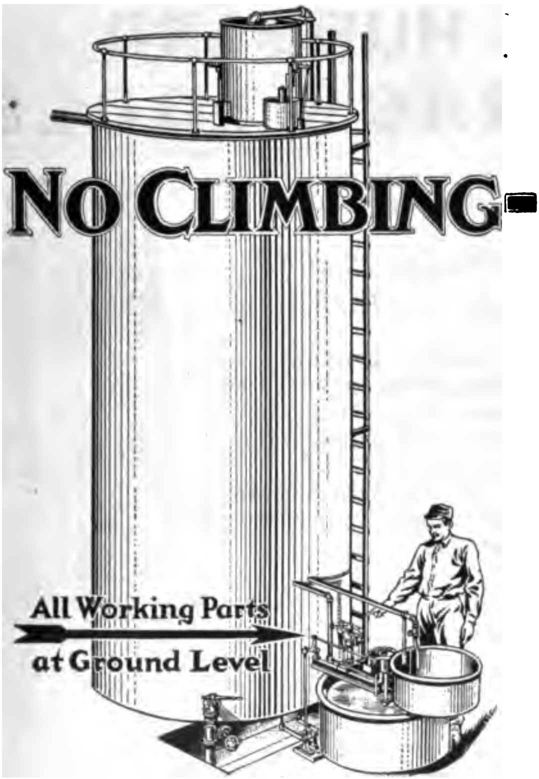
The simplicity—the price—the freedom from trouble appeal to all "men who know."

Booth Water Softeners are being built to justify your confidence — you owe it to yourself to examine the Booth—as soon as you can conveniently do so—In the meantime—write for booklet, "Hard Water Made Soft." —It will give you further evidence in support of our claims.—We invite you to send for it today.

L. M. BOOTH COMPANY

CHICAGO, Fisher Building

NEW YORK, 136 Liberty St.



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IN THE

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"Proved Best by Every Test."

OUR TRACK CHISELS ARE MADE FROM THE BEST CRUCIBLE TOOL STEEL THAT CAN BE PRODUCED FOR THIS PURPOSE.

EVERY TRACK TOOL WE MAKE IS SOLD UNDER AN ABSOLUTE GUARANTEE.

OUR TRACK SHOVELS ARE STANDARD ON MANY ROADS

OUR LOCOMOTIVE SCOOPS ARE KNOWN TO EVERY FIREMAN.

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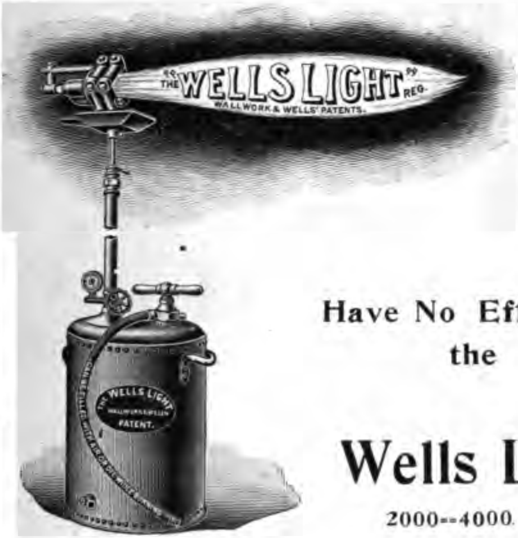

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Have No Effect on the

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Standard Switch Lamp

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Most Economical in Up-Keep

Sectional view of Adlake Non-Sweating Ventilation Showing Direction of Air Currents.

ADLAKE VENTILATION

means highest signaling efficiency under all conditions. Sweating is entirely eliminated. Lamp bodies are not destroyed by corrosion. The flame is not affected by climatic conditions.

No. 63 Flat Flame
no chimney

No. 51
with chimney

LONG TIME BURNERS

Long Time Burners require attention but twice a week.

Consume less oil and give a more satisfactory light than any other Burner made.

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Self-Measuring Oil Storage Systems

are made to add Convenience, Safety and Economy

In Railroad Oil Distribution.

Any number of oils are easily handled. No matter what quantities are stored and dispensed, a Bowser meets all the requirements.

The storekeeper can easily check up the amount of oil on hand because each outfit is provided with a gauge stick that tells at a glance the approximate amount of oil in the tank.

For valuable information write for Bulletin No. 38.

S. F. Bowser & Company, Inc.
Fort Wayne, Ind.

BOWSER

ADJUSTABLE MEASURE RAIL-ROAD TABLE TANK

is for use in storing and handling illuminating oils, etc., in lamp rooms and stations. It provides for storing the liquid in a neat, clean and convenient manner and delivering into lamps or other containers in exact predetermined quantities.

THE OIL IS KEPT FREE FROM DIRT.

THE EFFICIENCY OF THE OIL IS PRESERVED.

THE FIRE HAZARD IS GREATLY REDUCED.

The table provides a place on which the lamps may be set for filling. The pump may be easily regulated to exactly fill different sized lamps in general use. It is the most economical outfit made; complete in every detail.

For full information write for Bulletin No. 38.

S. F. BOWSER & CO., Inc., Ft. Wayne, Indiana

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REGISTERING MEASURE

Designed and constructed to measure and control the flow of oil through pipe lines.

Bowser Registering Measures are made in many sizes so as to be adapted to a diversity of uses, such as measuring oil delivered to oil-burning locomotives, stationary boilers and for recording oils delivered to large storage tanks, etc.

The measures will record any quantity up to 100,000 gallons, then repeating. They may be set to pump a predetermined quantity, and when the required number of gallons has passed through, the flow is shut off automatically.

Bowser Registering Measures are used in large numbers and are giving excellent satisfaction. Will furnish an accurate and efficient method for computing the cost of the consumption of oils.

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612 Howard St.
SAN FRANCISCO

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NEW YORK

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PHILADELPHIA

66-68 Frazer Ave.
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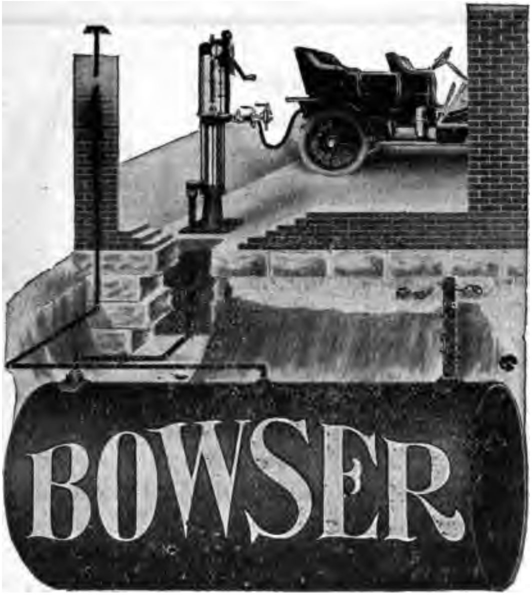

Underground Gasolene Tank

PREVENTS deterioration and contamination—keeps the **life** in the fuel. Prevents evaporation—gives you **all** the gasolene you buy. Prevents excessive expense—holds a quantity that can be bought at **wholesale.** Prevents danger—keeps the supply away from sparks and fire. Prevents delay—gasolene is at hand when you **want** it. Soon saves its cost. **The Bowser is the standard outfit.**

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612 Howard St., San Francisco

Type C Johnson Car Re-placers

C left hand

C right hand

Straddles the rail—needs no spikes, clamps or fasteners

Rests on rail both front and rear

Adjusts itself to different heights of rail

Forms a friction grip with rail during the operation

Brings rails to guage during replacement

Distributes the load on the Rail, not one or two ties

Range and Capacities of different types

Type		Locomotive capacity	Throat opening	Wgt. each
M	for rail 12 - 45 lbs. if not over 3½ in. high	20 ton	2 in.	30
C	" " up to 65 " " " " 4½ " "	30 "	2½ "	60
B	" " " " 80 " " " " 5 " "	50 "	3¼ "	110
A	" " " " 100 " " " " 5½ " "	80 "	3½ "	145
Z	" " " " 100 " " " " 6 " "	100 "	3½ "	165

The Johnson Wrecking Frog Company

325 Citizens Bldg. **Cleveland, O**

Type Z Johnson Car Re-placers

Z left hand

Z right hand

Straddles the rail—needs no spikes, clamps or fasteners

Rests on rail both front and rear

Adjusts itself to different heights of rail

Forms a friction grip with rail during the operation

Brings rails to gauge during replacement

Distributes the load on the Rail, not one or two ties

Range and capicity of different types

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A	" " " " 100 " " " " 5½ " "	80 "	3½ "	145
Z	" " " " 100 " " " " 6 " "	100 "	3½ "	165

The Johnson Wrecking Frog Company

325 Citizens Bldg. **Cleveland, O.**

The American Railway Signal Company

offer the best Mechanisms in Signal Apparatus yet placed before the Railroad world.

The Signal without a dash pot is the

Perfection of Operation

Our Electric Interlccker has many unique and valuable features not found in other machines.

In our AUTOMATIC BLOCK SIGNAL the mechanism can be used to operate ONE BLADE in TWO or THREE positions, TWO BLADES in TWO or THREE positions separately or both at the same time, either in the upper or lower quadrant, and adapted to any type or pattern of semaphore castings. With this mechanism the blade can be stopped at any angle and immediately returned to the proper signal indication without returning to the stop position.

Switch Instruments--Electric Switch Locks--Relays--Crossing Alarms, Etc.

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Cleveland, Ohio, U. S. A.

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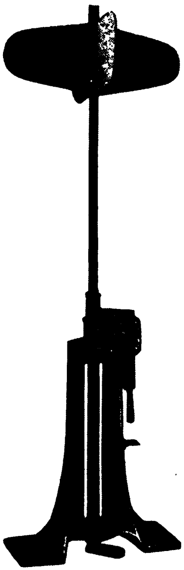
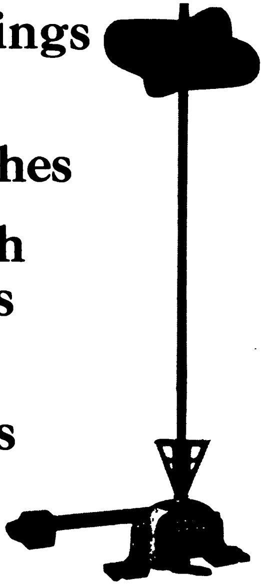


Crossings

Split Switches

Switch Stands

Rail Braces



The Cincinnati Frog & Switch Company

Manufacturers of

Track Equipment for

Steam and Electric Railroads

Mines and Mills

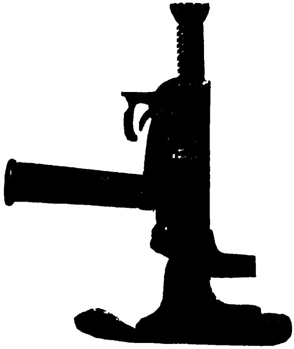
Cincinnati, O.

NO. 20 DROP TRACK JACK

MAXON PATENT

The Maxon Patent Jack is the invention of one of the most practical roadmasters of the country, and is both simple and durable.

The Jack is made in various sizes and of different capacities, a couple of them being shown herein.



The Drop Track Jack gives perfect control of the track without any danger of slipping, and has given the greatest satisfaction for twenty years.

The Foot Lift Screw Jack is also very popular and is used extensively on many of the principal railroads of the country.

These Jacks are Manufactured by

THE DAYTON IRON WORKS CO.

successors to

The Boyer & Radford Mfg., Co.

DAYTON, OHIO

NO. 12 FOOT LIFT SCREW JACK

MAXON PATENT

The Maxon Patent Jack is the invention of one of the most practical roadmasters of the country, and is both simple and durable.

The Jack is made in various sizes and of different capacities, a couple of them being shown herein.

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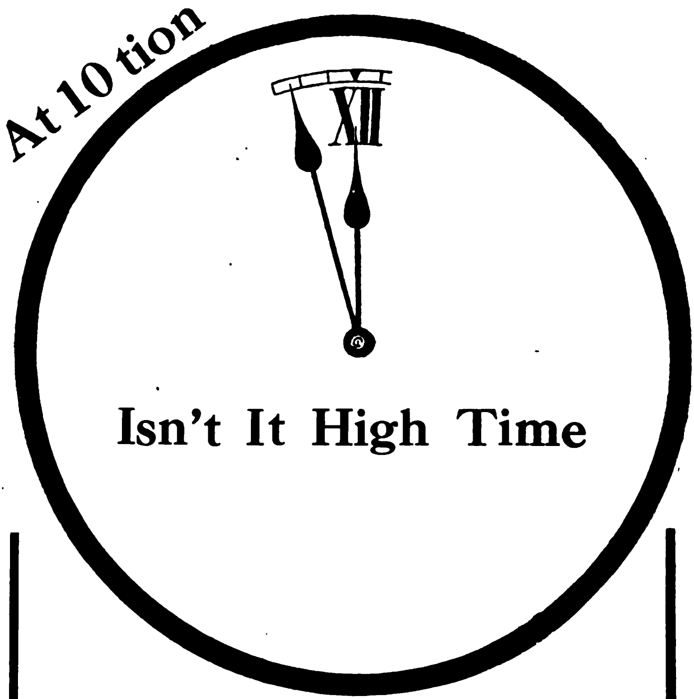

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Have Won out

in practically every test on

New Specification Rails

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Can you do this with the steel tapes **you are using?**

BUY THE

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STEEL CHAIN TAPES

and get the best

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Pressed Wrought Iron
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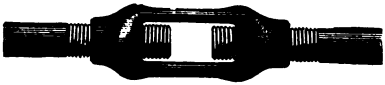

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Adopted as Standard by
a Majority of Railroads in
the United States.

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AND ALL

TRACK SPECIALS

OF

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Solid Manganese and Manganese Insert Construction

DESIGN WORKMANSHIP AND MATERIAL ABSOLUTELY HIGH GRADE THROUGHOUT.

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Frogs, Crossings, Switches, Etc.

FOR MOST SEVERE SERVICE

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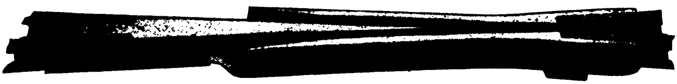
MODEL R-N-R RIGID FROG



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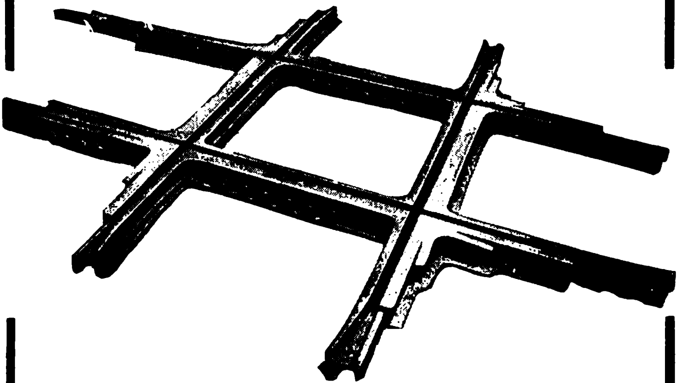
CROSSINGS, FROGS, SWITCHES

FOR STEAM AND ELECTRIC RAILWAYS

Regular and Manganese Construction

The secret of success in solid manganese construction is—
First, the quality of the steel—there was never any made better than ours.
Second, the designing of sections and distribution of metal—we are authority in this particular.



The above cut shows one of our various types of Solid Manganese Crossings.

Our designs are the result of 15 years' practical experience in Manganese.

Our Manganese is guaranteed to Government specifications.

THE INDIANAPOLIS SWITCH & FROG CO.

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J. A. FOULKS, Representative

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WE MANUFACTURE

RIVETING HAMMERS
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CAULKING HAMMERS
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With Outside and Inside Throttle Lever

AIR DRILLS

Reversible and Non-Reversible

FOR REAMING and TAPPING
FLUE-ROLLING and WOOD BORING

SHIPPED ON APPROVAL

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"BOWES" HOSE COUPLING

Fitted with CLEVELAND NEVER-SLIP Hose Clamp

OVER 1,000,000 IN USE EVERYWHERE

THE CLEVELAND PNEUMATIC TOOL CO.

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New York, Philadelphia, Pittsburg, Montreal, Toronto

Denver, Salt Lake City, El Paso, San Francisco, Seattle

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Continuous
Frog and Switch
Joint

Continuous Step or Compromise Joint

The Rail Joint Co.

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NEW YORK CITY.

Continuous Girder

Additional safety and economy in

TRACK MAINTENANCE

has been proved by the use of Continuous, Weber and Wolhaupter base-supported rail joints—after fourteen (14) years' service. Over 50,000 miles of railway track equipped with our products.

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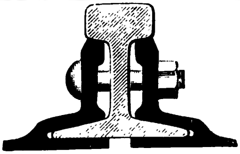
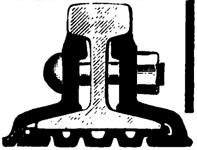


WEBER



WOLHAUPTER

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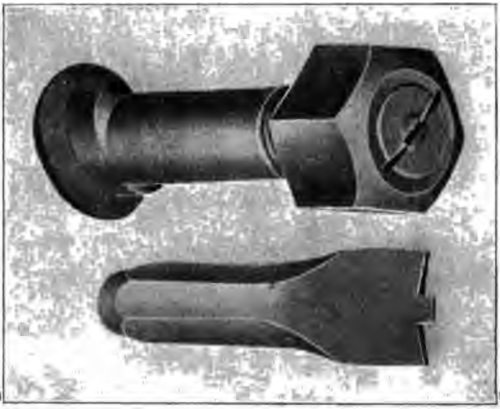

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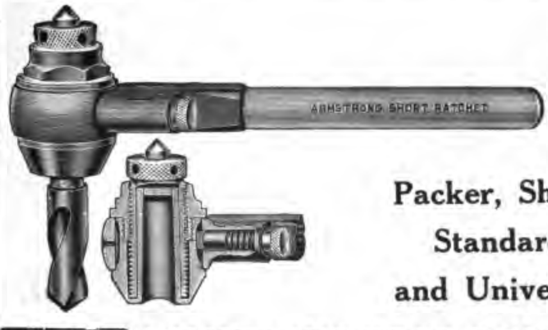

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All of these plates are rolled from new steel.

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The Elyria Iron & Steel Co.

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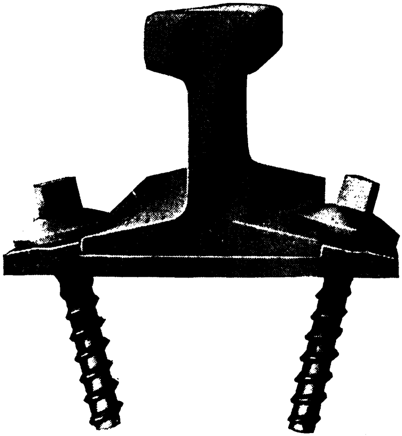
Furnished with or without short flanges or legs on bottom.



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A flat bottom plate using perpendicular screw spike instead of inclined spike. This plate affords means for drainage of brine and water.

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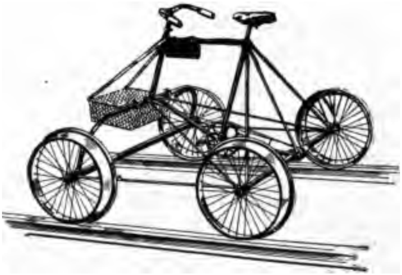

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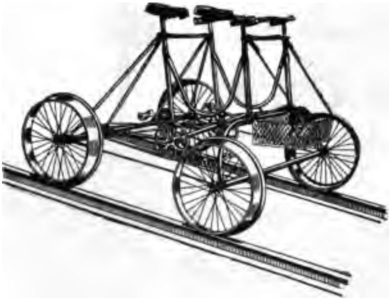

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INTERLOCKING SWITCH STAND

Track Standards should include devices having a small number of special parts so as to keep down the stock in the storeroom. The Foster Interlocking Switch Stand has interlock to engage your standard lock bar, and chain sheave to connect with distant signal. It can be installed on facing point switches without special tools or appliances. It secures the points with two independent connections, the interlock being separate from the stand. Switch closed for main line, points interlocked and signals clear. Switch crank locked on dead center. Points held by switch rod and lock bar independently. Interlock fastened to ties separate from stand.

These stands are giving excellent satisfaction in service and I will ship them subject to your approval after you have tested them in your track.

One Throw of
ONE LEVER
operates Switch
Interlock Signals

FRANK M. FOSTER

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Track Standards should include devices which are the simplest to operate. The Foster Interlocking Switch Stand operates switch points, interlock and signals with one movement of one lever parallel with the track. To switch cars on main line and hold distant signal at danger for protection move the lever between the position shown below and the vertical. If the switch is left open the distant signal will remain at danger.

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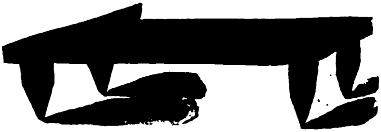

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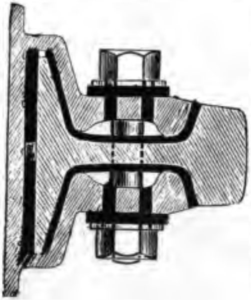
The Bossert Insulated Rail Joint



is a one-piece joint that clamps the rail ends together solidly as one unit. Compels the rail ends to bend uniformly; prevents the rail ends from becoming battered or worn; increases the life of the rail and decreases the wear on the fibre insulation; offers no obstacles to scrapers or flanges of snow-plows. can be installed quickly and easily. renewals made without breaking track.

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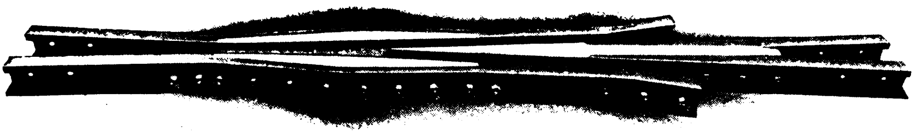

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